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THE BARBITURATES AND OTHER HYPNOTICS IN LABOR[1]

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NUMEROUS reports have appeared in the literature concerning the use of various drugs to relieve the pains of labor. Such studies have been confined only to the effects of one drug or combination of drugs, but have never embraced a critical comparison of different methods applied to equal groups of similar unselected patients in the same institution.

On July 1, 1931, at the Boston Lying-in Hospital was begun an investigation into the amnesic, analgesic, and anæsthetic properties in labor of drugs already in more or less common use, as well as other agents not at that time often employed for the same purpose. To this end two specially trained graduate nurses, one for day and one for night duty, were engaged to assume immediate charge of the patients under investigation. These nurses were required to keep detailed and extensive anæsthesic records of each patient upon forms provided for the purpose. This work was made possible through the generosity of Mrs. Albert C. Burrage, to whom the authors wish to express their gratitude.

The investigation was completed 1 year later, and the results obtained are the basis for this report. Eight hundred and sixty patients were studied and eight types of anæsthesia were used. These were: pantopon and scopolamine, pantopon and rectal ether, pernocton, sodium amytal and scopolamine, pentobarbital and scopolamine, sodium amytal and rectal ether, pentobarbital and rectal ether, and pentobarbital and paraldehyde. There were 100 cases in each series, except in the group in which sodium amytal and scopolamine were employed, and this consisted of 160 cases. During the expulsive stage nitrous oxide and oxygen was given all patients, ether being added on the rare occasions when it was required.

The first essential in any method for the relief of the pains of labor is absolute safety for both mother and infant. None of our 860 patients died or was in any way adversely affected. No serious pulmonary or other complications were noted during labor or in the puerperium. Since the barbiturates have considerable effect in diminishing reflex responses, they should not be used when the patient has any infection of the upper or lower respiratory tract. For the same reason they should be avoided when the patient has recently eaten, since vomiting may occur with danger of aspiration of the vomitus. The uncorrected stillbirth rate was 0.93 per cent, which compares favorably with a rate of 1.4 per cent during 1920, a year selected at random for comparison, since at that time no analgesic drugs were in systematic use in the hospital. Seven infants were stillborn. The cause of stillbirth and the type of anæsthesia used in each case is shown in Table I.

[1] From the Department of Obstetrics, Harvard Medical School, and the Boston Lying-in Hospital.

TABLE I.—STILL BIRTHS IN 860 DELIVERIES

Hospital Admission Number	Cause of stillbirth	Method of anæsthesia
49353	Knot in cord (low forceps delivery)	Pentobarbital and scopolamine
49504	Fetal heart rate rapid before delivery. Baby passing meconium. Difficult operative delivery (low forceps)	Pantopon and scopolamine
49224	Intra-uterine asphyxia. Petechial intracranial hæmorrhages (autopsy)	Sodium amytal and scopolamine
51322	Anencephalic monster	Pentobarbital and scopolamine
51087	Cord three times about neck tightly	Sodium amytal and rectal ether
51506	Baby passing meconium. Fetal heart not heard before delivery (low forceps)	Pentobarbital and rectal ether
51616	Baby passing meconium. Cord tightly about neck. Microscopic examination of placenta showed premature separation with calcification, thrombosis, and hæmorrhage	Pentobarbital and rectal ether

It was our aim to produce complete amnesia from the time the drugs were first administered until the patient awoke in bed in the ward, so that there would be no memory whatever of her labor. We wish to make it clear that simple amelioration of suffering, which has seemed to satisfy many writers, notably those who have employed morphine and rectal ether, would be classified by us as a failure, or at best as only a partial success. In Chart 1 are shown the results obtained in producing amnesia.

It is highly desirable that excitement should be minimal since a restless patient is difficult to control and, unless constantly watched, may do herself an injury. Since many of the drugs we used were likely to cause excitement, particularly with the onset of each uterine contraction, this element proved of considerable importance. No patient in labor who is given any hypnotic drug should ever be left, even momentarily, without constant, competent nursing supervision. No such medication should be administered when labor is conducted in the patient's home. It is an affair for a hospital alone, and all relatives and friends must be excluded from the room. No patient, at completion of labor, should be left alone until she is thoroughly awake and able to answer questions intelligently (Chart 2).

PANTOPON AND SCOPOLAMINE

Since morphine and scopolamine or "twilight sleep" and morphine and rectal ether are the two methods which have been most largely used, we first directed our attention to them. We substituted pantopon for morphine in both groups, since it has been stated that this preparation of opium is less toxic to the fetus *in utero*. One hundred patients were given pantopon and scopolamine. All cases in this series, as in the 7 others, were unselected, the drugs being administered to any patient entering the hospital who presented no major abnormality. The initial dose of pantopon was one-third of a grain. One hundred and fiftieth of a grain of scopolamine was given 45 minutes later and the scopolamine was repeated in the same dosage as often as was necessary to dull the sensorium. Medication was begun in primiparæ when the cervix was two fingers dilated and the uterine contractions coming every 3 to 5 minutes and lasting 45 seconds. Multiparæ received the same medication, regardless of the condition of the cervix, when the pains were coming with the same frequency and lasting for the same time. The pantopon was never repeated. The disadvantages of this method proved considerable. Only 39 per cent of patients enjoyed complete and 34 per cent partial amnesia, while in 27 per cent no relief at all was experienced. The degree of excitement was moderate: 10 per cent of the patients required control. There also seemed to be an increase in the frequency of postpartum hæmorrhage, since 25 per cent lost over 300 cubic centimeters of blood (see Table VII).

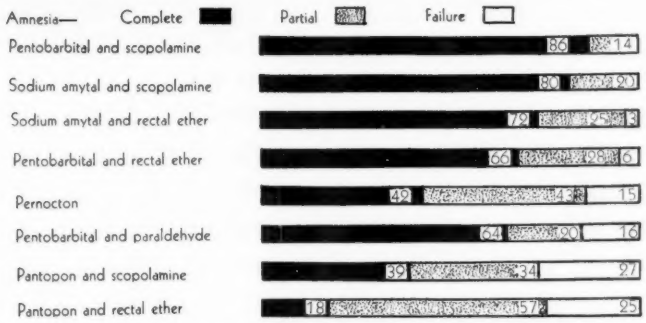

Chart 1. Effect of the drugs in producing amnesia.

The effect on the babies was striking. Only 33 per cent breathed immediately at birth (Chart 3). The balance required the removal of mucus or various methods of resuscitation.

A study of cases in the Outpatient Department, where no anæsthetics are used during normal delivery, revealed that only 1.9 per cent of the living full term infants did not breathe immediately as soon as they were born. A similar study of patients delivered in the hospital to whom only gas-oxygen and ether were given showed that 80 per cent of infants made their initial respiration as soon as they were delivered.

Table V indicates that in primiparæ labor was on the average prolonged when pantopon and scopolamine were employed. There was also an increase in the average interval between the first medication and delivery in primiparæ as shown in Table VI. This prolongation is all the more striking, since these drugs were not administered until labor was definitely under way, as was evidenced by two fingers dilatation of the cervix, and an interval between uterine contractions of from 3 to 5 minutes with a duration of 45 seconds. No such effects were evident with multiparæ.

There was, moreover, an operative incidence of 46 per cent, the highest in any method we used.

PANTOPON AND RECTAL ETHER

A modification of the so called Gwathmey synergistic analgesia was next studied. An initial dose of one-third of a grain of pantopon with 2 cubic centimeters of 50 per cent magnesium sulphate solution, was administered. Twenty minutes later 2 cubic centimeters of magnesium sulphate solution was given without the morphine. In 20 minutes to 1 hour the usual dose of rectal ether, quinine, and olive oil was given by rectum and accompanied by another intramuscular injection of 2 cubic centimeters of magnesium sulphate solution. The rectal ether was repeated every 3 to 4 hours if necessary. From the point of amnesia this method proved to be the least satisfactory, since only 18 per cent of our patients in the series of 100 cases experienced complete and 67 per cent partial loss of memory. There were 25 per cent of failures. The incidence of excitement, however, was low, there being only 4 per cent who required restraint. Blood loss of over 300 cubic centimeters occurred in 16 per cent of the cases. The effect on the baby was not as marked as that of pantopon and scopolamine, since 53 per cent breathed immediately at birth. As a result of the study of these two series of cases we believe that morphine or any of its derivatives has no place during labor as they distinctly delay the initial respirations of the child. While no infants were lost because of the administration of pantopon to their mothers, the period of time which elapsed between their birth and their first breath was on many occasions sufficiently prolonged to cause the obstetrician considerable anxiety.

PERNOCTON

We next used pernocton (10 per cent aqueous solution of the sodium salt of the second-

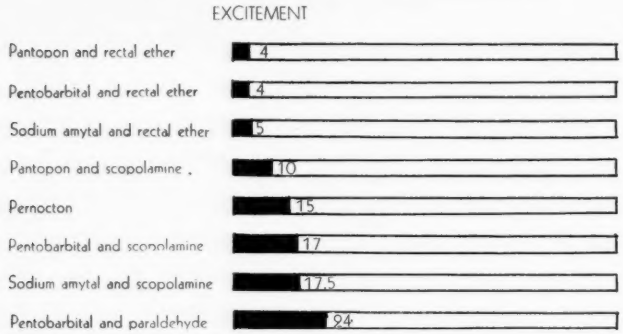

Chart 2. Effect of the drugs in producing excitement.

ary butyl-beta-bromallyl barbituric acid) in 100 cases. This drug is administered intravenously. Since, if it escapes into the tissues, it may produce necrosis, it should be administered only by a physician. The dose employed was 1 cubic centimeter per 30 pounds of body weight, given at the rate of 1 cubic centimeter every 2 minutes. The average dose was from 4 to 6 cubic centimeters. It was repeated if necessary at the end of 3 hours in half the original dose.

By referring to Tables V and VI it will be noted that with this drug the average length of labor was not shortened in primiparæ, but was somewhat shortened in multiparæ. The average time interval between the first medication and delivery, was, however, notably decreased in both types of patients. This is accounted for by the fact that the action of pernocton is evanescent and can be given only at the end of the first stage of labor. Only 42 per cent of our patients experienced complete amnesia although 43 per cent had some relief. Fifteen per cent were unduly excited, and 15 per cent exhibited convulsive movements after receiving the drug. So far as the babies were concerned the effect was similar to that of pantopon and rectal ether, since only 53 per cent breathed immediately at birth. We consider that this drug is not suitable for use during labor.

SODIUM AMYTAL AND SCOPOLAMINE

The study of sodium amytal (sodium isoamyl-ethyl-barbiturate) and of pentobarbital (sodium ethyl [1 methyl-butyl] barbiturate) in combination with scopolamine or rectal ether was next undertaken. There were 160 patients who received sodium amytal and scopolamine. The initial dose of sodium amytal by mouth was from 9 to 12 grains, depending upon the weight of the patient. This drug was repeated 3 to 4 hours later in from 3 to 6 grain doses if indicated. Forty-five minutes after the initial dose of sodium amytal one one-hundredth or one one-hundred and fiftieth of scopolamine was given subcutaneously and was repeated later as soon as the patient began to complain of pain. The resultant amnesia was highly satisfactory, 80 per cent remembering nothing of their labors and 20 per cent recalling only isolated incidents. There were no failures. There was, however, a rather high degree of excitement since 17.5 per cent required restraint. The effect on the baby was good, since 61 per cent breathed immediately. There was also a comparatively low operative incidence.

PENTOBARBITAL AND SCOPOLAMINE

Pentobarbital and scopolamine were used with 100 of the patients. We found that our patients regained consciousness much earlier after delivery than those who had received sodium amytal and scopolamine, and therefore required less postpartum watching. The initial dose is from 4½ to 6 grains by mouth which may be increased if desired, and it is repeated according to the same indications as govern the use of sodium amytal. The best results in amnesia were obtained by this method, since 86 per cent remembered

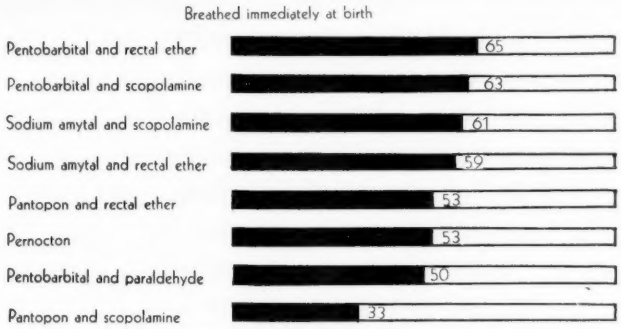

Chart 3. Effect on initial respirations of infants.

nothing of their labor and 14 per cent recalled only isolated incidents. Sixty-three per cent of the children breathed immediately at birth.

SODIUM AMYTAL AND RECTAL ETHER

Rectal ether was then combined with sodium amytal and with pentobarbital. Sodium amytal and rectal ether were given to 100 of the patients with 72 per cent complete and 25 per cent partial amnesia and 3 failures. Fifty-nine per cent of the babies breathed immediately at birth.

PENTOBARBITAL AND RECTAL ETHER

One hundred patients received pentobarbital and rectal ether. Amnesia was complete in 66 per cent and partial in 28 per cent. There were six failures. It therefore appeared to be somewhat less effective than sodium amytal and rectal ether. The incidence of excitement was low, there being only 4 per cent of patients requiring restraint, which is about the same as the effect produced by sodium amytal and rectal ether, where there was 5 per cent of restlessness.

It is evident that the use of the barbiturates with rectal ether causes little restlessness but that the amnesia is not all that is desired. It is apparently necessary to employ scopolamine to obtain a high percentage of success in producing loss of memory of labor.

PENTOBARBITAL AND PARALDEHYDE

The final group of patients were given pentobarbital and paraldehyde at the suggestion of H. H. Rosenfield who has had considerable experience with this type of analgesia. One hundred patients were included in this series. Our results were less satisfactory than those of Rosenfield, since we found the incidence of complete amnesia to be 64 per cent. Twenty per cent had partial amnesia, while there were 16 per cent of failures. Fifty per cent of the babies breathed immediately at birth. The incidence of excitement was the highest in our series, since 24 per cent had to be restrained. We therefore feel that in our hands this combination of drugs has not been sufficiently successful to warrant its continued use.

GENERAL OBSERVATIONS

The effect of the different drugs was studied upon the pulse rate, the frequency of respirations, the systolic blood pressure, the total length of labor, the time interval between the first medication and delivery, the operative incidence, and the amount of blood lost during or immediately after third stage of labor.

Pulse rate. Observations on the pulse rate were made on entrance, one hour after the first medication, one hour before delivery, and one hour after delivery (Table II).

1. *One hour after the first medication.* Sixty-seven per cent of all groups showed no significant variations in the pulse rate, since the pulse either remained the same or rose or fell less than ten beats. The greatest variation from the normal was shown by pentobarbital and paraldehyde since in 30 per cent of cases the pulse rose over 10 beats.

TABLE II.—PULSE

		Pantopon and scopolamine	Pantopon and rectal ether	Pernocton	Sodium amytal and scopolamine	Pentobarbital and scopolamine	Sodium amytal and rectal ether	Pentobarbital and rectal ether	Pentobarbital and paraldehyde
1 hour after medication	No change	9	10	20	9.4	17	18	15	13
	Rose −10	26	35	21	34	29	31	23	22
	Rose 10−20	17	8	13	7	9	11	11	18
	Rose 20−30	6	3	4	5	2	2	2	5
	Rose 30−40	1	1	1	2.5	4	1	2	4
	Rose 40+	2	1	2	0.6	0	0	1	3
	Fell −10	23	31	27	29	22	28	31	20
	Fell 10−15	4	7	6	5	7	3	6	12
	Fell 15−20	5	4	2	2.5	4	1	5	0
	Fell 20−30	5	0	3	3	4	5	2	2
	Fell 30−40	1	0	1	2	1	0	1	1
	Fell 40+	1	0	0	0	1	0	1	0
1 hour before delivery	No change	7	10	16	9.4	11	16	11	13
	Rose −10	30	37	22	30	20	27	29	23
	Rose 10−20	19	17	10	12.1	26	20	13	14
	Rose 20−30	6	7	11	6.2	9	9	7	13
	Rose 30−40	1	3	0	8	2	5	5	4
	Rose 40+	1	0	3	3.1	2	2	3	5
	Fell −10	16	17	26	13.1	13	12	13	11
	Fell 10−15	6	7	2	7.5	6	2	4	12
	Fell 15−20	6	1	5	4.4	4	4	7	0
	Fell 20−30	4	1	3	2.5	4	2	3	2
	Fell 30−40	3	0	1	2.5	2	1	0	1
	Fell 40+	1	0	1	1.2	1	0	0	2
1 hour after delivery	No change	6	9	8	5	15	2	15	12
	Rose −10	16	20	11	20	23	29	22	10
	Rose 10−20	25	17	17	8.2	15	18	9	19
	Rose 20−30	5	6	11	8.7	3	7	7	6
	Rose 30−40	3	2	0	3.3	1	3	1	2
	Rose 40+	1	5	2	3.7	0	3	5	2
	Fell −10	20	27	25	20.3	20	20	16	25
	Fell 10−15	7	6	7	10	4	5	5	18
	Fell 15−20	4	2	11	10	9	4	9	6
	Fell 20−30	6	5	6	6.4	6	4	4	2
	Fell 30−40	6	0	1	1.9	2	4	4	4
	Fell 40+	1	1	1	2.5	2	1	3	4

2. *One hour before delivery.* In 53 per cent of all cases there was no significant variation. Thirty-nine per cent of the patients who received pentobarbital and scopolamine and 36 per cent of those receiving sodium amytal and scopolamine and pentobarbital and paraldehyde exhibited a rise in pulse rate of above 10 per minute.

3. *One hour after delivery.* Forty-nine per cent of all groups showed no significant

TABLE III.—RESPIRATIONS

		Pantopon and scopolamine	Pantopon and rectal ether	Pernocton	Sodium amytal and scopolamine	Pentobarbital and scopolamine	Sodium amytal and rectal ether	Pentobarbital and rectal ether	Pentobarbital and paraldehyde
1 hour after medication	No change	55	57	66	52	61	71	66	44
	Fell − 5	23	16	16	15	19	13	16	17
	Fell 5−10	2	0	0	4	0	0	0	4
	Fell 10+	0	0	0	0	0	0	0	0
	Rose − 5	20	27	15	27	19	16	18	28
	Rose 5−10	0	0	3	2	1	0	0	6
	Rose 10−15	0	0	0	0	0	0	0	1
	Rose 15+	0	0	0	0	0	0	0	0
1 hour before delivery	No change	32	44	39	35	27	31	25	47
	Fell − 5	14	7	8	7.6	10	11	5	17
	Fell 5−10	1	8	0	0	0	1	0	1
	Fell 10+	0	0	0	0	0	0	0	0
	Rose − 5	47	48	48	47.5	56	55	62	27
	Rose 5−10	5	1	4	8.7	7	2	7	3
	Rose 10−15	1	0	0	0.6	0	0	1	4
	Rose 15+	0	0	1	0.6	0	0	0	1
1 hour after delivery	No change	47	38	50	56.5	56	48	51	30
	Fell − 5	25	27	25	20	22	18	20	36
	Fell 5−10	1	3	2	0.6	3	1	0	7
	Fell 10+	1	0	0	0	0	0	0	6
	Rose − 5	20	30	20	18	19	30	24	20
	Rose 5−10	5	2	3	3.7	0	2	5	1
	Rose 10−15	1	0	0	0	0	1	0	0
	Rose 15+	0	0	0	1.2	0	0	0	0

changes. Thirty per cent of the patients receiving pernocton and 29 per cent of those receiving pentobarbital and scopolamine exhibited a rise in pulse of over 10 beats. However, 0.26 per cent of those receiving pernocton and 34 per cent of those to whom pentobarbital and paraldehyde was administered showed a fall in pulse rate of over 10 beats per minute.

The study of pulse variation reveals no drug or combination of drugs that produced any consistent effect.

Respirations. Similar observations upon the respiratory rate are noted in Table III.

1. *One hour after the first medication.* Fifty-nine per cent of the patients in all eight groups showed no change in their respirations, while in 17 per cent the respirations fell less than 5 and in 21 per cent increased less than 5 per minute. In 97 per cent, therefore, there were no significant variations from the normal.

2. *One hour before delivery.* Thirty-five per cent of all patients exhibited no change. In 10 per cent there was a drop of less than 6 and in 48.5 per cent an increase of less than 5. Ninety-three and five-tenths per cent showed practically no change from normal.

3. *One hour after delivery.* Forty-seven per cent revealed no variation from the previous observation; in 24 per cent the fall was less than 5 and in 22.6 per cent the rise was less than 5. In 93.6 per cent there was no change worthy of note.

The drugs employed exerted little effect upon the respiratory rate, nor did any particular drug, or combination of drugs, have any characteristic influence.

TABLE IV.—SYSTOLIC BLOOD PRESSURE

		Pantopon and scopolamine	Pantopon and rectal ether	Pernocton	Sodium amytal and scopolamine	Pentobarbital and scopolamine	Sodium amytal and rectal ether	Pentobarbital and rectal ether	Pentobarbital and paraldehyde
1 hour after first medication	No change	14	12	8	10.0	15	17	9	18
	Fell −10	30	27	27	25.1	31	31	35	26
	Fell 10−20	15	17	21	14.3	14	13	11	16
	Fell 20+	1	6	10	5.6	6	11	14	10
	Rose −10	20	30	22	25.6	29	22	21	18
	Rose 10−10	13	5	10	11.9	3	4	7	6
	Rose 20+	7	2	2	7.5	2	2	3	6
1 hour before delivery	No change	17	7	6	10	12	10	6	23
	Fell −10	19	24	32	24	29	38	29	19
	Fell 10−20	10	13	18	13	15	8	15	8
	Fell 20+	6	5	10	9	10	7	10	4
	Rose −10	25	30	21	27	28	26	24	27
	Rose 10−20	15	16	12	9	3	6	11	9
	Rose 20+	8	5	1	8	3	5	5	10
1 hour after delivery	No change	8	7	6	9.0	8	4	6	18
	Fell −10	29	27	32	25.0	25	28	18	17
	Fell 10−20	20	23	22	17.0	20	25	24	7
	Fell 20−30	8	16	16	9.0	17	15	11	17
	Fell 30−40	2	3	4	9.0	11	5	9	12
	Rose −10	20	17	13	15.0	8	10	15	11
	Rose 10−20	7	4	4	7.0	4	5	6	7
	Rose 20+	4	2	1	4.4	2	1	2	6

Systolic blood pressure. 1. *One hour after the first medication.* Twelve and nine-tenths per cent showed no change, 29 per cent fell less than 10 millimeters, and 24 per cent rose less than 10 millimeters, so that in 65.9 per cent there was no noteworthy alteration.

2. *One hour before delivery.* Eleven and four-tenths per cent showed no changes, 26.8 per cent fell less than 10 millimeters, and 26 per cent rose less than 10 millimeters. In 64.2 per cent there was no significant change.

3. *One hour after delivery.* Nine and three-tenths per cent showed no changes, 25 per cent fell less than 10 millimeters, and 13.6 per cent rose less than 10 millimeters. In 47.9 per cent there was no important alteration.

Of the patients receiving pernocton the blood pressure fell 20 millimeters in 10 per cent 1 hour after its first medication, 10 per cent 1 hour before delivery, and 22 per cent 1 hour after delivery. Of those receiving pentobarbital and rectal ether, 10 per cent exhibited a like fall 1 hour after receiving their first medication, 29 per cent 1 hour before delivery, and 14 per cent 1 hour after delivery. These two groups showed the highest percentages of fall in blood pressure. In no instances were there significant elevations of blood pressure, thus indicating that an elevation of an existing hypertension, as in preeclamptic toxæmia, would be unlikely.

Total length of labor. The average duration of labor for both primiparæ and multiparæ is shown in Table V. Aside from a prolongation of labor in primiparæ, as already noted, delivered under pantopon and scopolamine, labor was not prolonged either in the entire series or in any particular group.

Interval between the first medication and delivery (Table VI). No significant variation

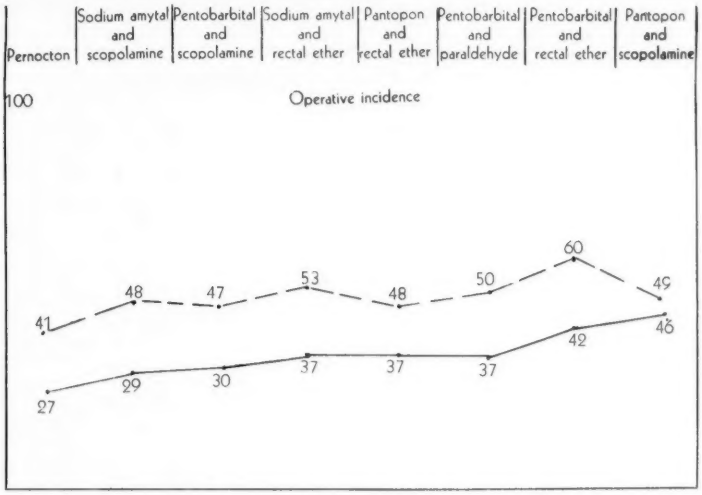

Chart 4. Operative incidence. Percentage of operative incidence——; percentage of primiparæ — — —.

is here noted, except in the case of pernocton, which, owing to its transient effect, was necessarily given late, and with pantopon and scopolamine in primiparæ, where the average interval was prolonged.

Operative incidence. The average operative incidence was 35.6 per cent, as compared with 44.6 per cent in 1920, when no hypnotic drugs were used.

Chart 4 indicates that pentobarbital and scopolamine and sodium amytal and scopolamine show low operative incidences and pantopon and scopolamine a high incidence, especially when compared with the percentages of primiparæ in each series.

TABLE V.—AVERAGE LENGTH OF LABOR*

PRIMIPARÆ	Hours	Minutes
Pantopon and scopolamine	23	46
Pantopon and rectal ether	17	46
Pernocton	14	27
Sodium amytal and scopolamine	14	45
Pentobarbital and scopolamine	14	6
Sodium amytal and rectal ether	16	15
Pentobarbital and rectal ether	19	6
Pentobarbital and paraldehyde	17	12
MULTIPARÆ		
Pantopon and scopolamine	13	24
Pantopon and rectal ether	12	26
Pernocton	8	25
Sodium amytal and scopolamine	12	45
Pentobarbital and scopolamine	9	37
Sodium amytal and rectal ether	10	52
Pentobarbital and rectal ether	13	15
Pentobarbital and paraldehyde	10	5

*The average length of labor was definitely prolonged in primiparæ delivered under pantopon and scopolamine.

Blood loss. The percentage of patients in each group losing over 300 cubic centimeters of blood is indicated in Table VII. The greatest blood loss was noted in the pantopon and scopolamine and pantopon and rectal ether group.

SUMMARY

1. The effect of eight hypnotic drugs or combination of drugs is reported. Eight hundred and sixty unselected patients were studied. They were divided into seven groups of 100 each, and one group in which sodium amytal and scopolamine was used, of 160 patients.

TABLE VI.—AVERAGE INTERVAL BETWEEN FIRST MEDICATION AND DELIVERY*

PRIMIPARÆ	Hours	Minutes
Pantopon and scopolamine	10	8
Pantopon and rectal ether	8	29
Pernocton	4	40
Sodium amytal and scopolamine	7	47
Pentobarbital and scopolamine	6	49
Sodium amytal and scopolamine	7	49
Pentobarbital and rectal ether	9	42
Pentobarbital and paraldehyde	8	32
MULTIPARÆ		
Pantopon and scopolamine	5	18
Pantopon and rectal ether	4	46
Pernocton	2	22
Sodium amytal and scopolamine	6	23
Pentobarbital and scopolamine	3	47
Sodium amytal and rectal ether	4	40
Pentobarbital and rectal ether	5	23
Pentobarbital and paraldehyde	4	35

*The average interval between the first medication and delivery was definitely prolonged in patients delivered under pantopon and scopolamine.

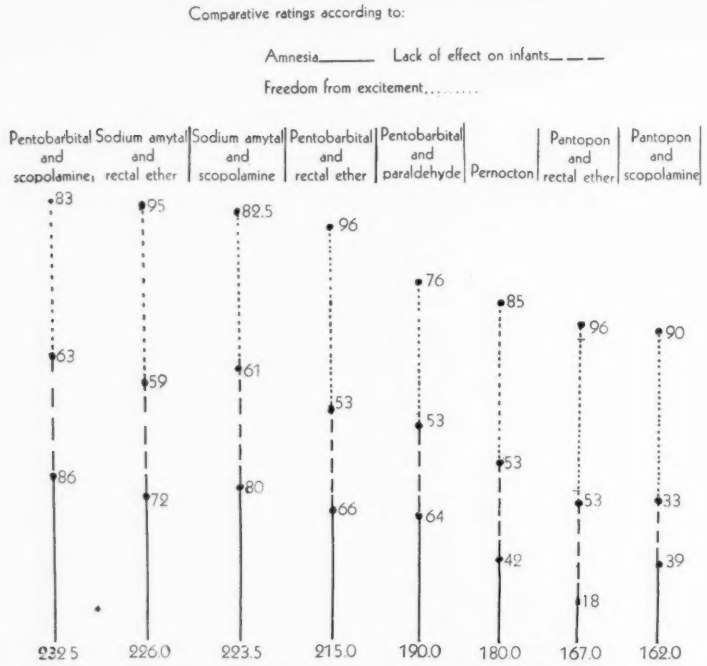

Chart 5. Comparative ratings of the various hypnotic drugs.

2. Pantopon and scopolamine in combination proved not to be satisfactory hypnotics, since only 34 per cent of patients had no memory of their labor. Only 33 per cent of the infants born to mothers who had received these drugs breathed immediately after birth. There was also a prolongation of labor in primiparæ, the operative incidence was high, and the incidence of blood lost was the highest encountered in the study, being 25 per cent.

3. With pantopon and rectal ether there was only 18 per cent of complete amnesia, the lowest in the series. Sixteen per cent of the patients lost over 300 cubic centimeters of blood, the second highest in the study. There was, however, a low incidence of excitement.

4. Pernocton is evanescent in its action and cannot be given until the end of the first stage of labor. It produces a low incidence of amnesia and considerable excitement.

5. Sodium amytal and scopolamine resulted in complete amnesia in 80 per cent of cases. No marked effect in delaying the initial respiration of the infants was noticed. There was, however, a fairly high incidence of restlessness, and the return to consciousness was prolonged.

6. Pentobarbital and scopolamine produced 86 per cent of complete amnesia, the highest in the study, and the greatest percentage of infants, 63, breathed immediately after birth. The operative incidence was low. The recovery after delivery was not lengthened. The frequency of excitement, however, was considerable, being 16.20 per cent. This is the only valid objection to the method.

TABLE VII.—BLOOD LOSS OVER 300 CUBIC CENTIMETERS*

	Per Cent
Pentobarbital and paraldehyde	3
Pentobarbital and scopolamine	3
Pentobarbital and rectal ether	5
Pernocton	10
Sodium amytal and scopolamine	12
Sodium amytal and rectal ether	15
Pantopon and rectal ether	16
Pantopon and scopolamine	25

*The greatest blood loss was noted in patients delivered under pantopon and scopolamine.

7. With sodium amytal and rectal ether there was little restlessness, but the percentage of complete amnesia was only 72 per cent.

8. Pentobarbital and rectal ether was even less effective in producing amnesia, although the absence of excitement was similar.

9. Pentobarbital and paraldehyde produced a moderate incidence of complete amnesia. Twenty-four per cent of the patients, however, were sufficiently excited to require restraint.

10. In no case in any group was there noted an untoward effect upon mother or child.

11. The pulse, respirations, or systolic blood pressure showed no characteristic variation during or immediately following labor in any group.

CONCLUSIONS

1. Chart 5, which is a composite of Charts 1, 2, and 3, shows the combined rating of each group, based on the percentages of complete amnesia, lack of effect on the infants, and freedom from excitement. According to this, pentobarbital and scopolamine is the most effective of any of the methods studied. It is now the standard method used at the Boston Lying-in Hospital, since by its use we may expect 86 per cent of absolute loss of memory of labor, 14 per cent of incomplete amnesia, and no failures. Its sole objection is the fairly high percentage of restlessness, which we control by the supplementary instillation of rectal ether.

2. We do not believe that pantopon, morphine, or any of its derivatives should be used during labor, as they have a marked effect in delaying the initial respirations of the infant.

3. The groups in which scopolamine or paraldehyde were used showed the highest percentage of restlessness. The best amnesia, however, was obtained when scopolamine was combined with the barbiturates.

4. Rectal ether, in combination with pantopon or the barbiturates, is productive of little restlessness, but the incidence of complete amnesia is considerably less than when scopolamine is used.

5. All methods used delayed the initial respirations of the infants to some extent, since a control series of cases in which delivery was effected without any anæsthetic showed only 1.9 per cent of infants who did not breathe immediately at birth. Another control series of patients delivered under nitrous oxide-oxygen and ether showed that 20 per cent did not breathe immediately upon delivery. It is likely that all hypnotic drugs or anæsthetics given to the mother may delay somewhat the initial respirations of the infant. That this is not a valid objection to the use of such medication, however, is shown by the low stillbirth rate in the series and the fact that each stillbirth can be accounted for by other reasons than the effect of the drugs given to the mother.

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CYST FORMATIONS OF THE SKULL[1]

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EXTRAVASATION of blood in the various layers of the scalp and skull will present different clinical and pathological aspects dependent on the location of the actual bleeding. If the effused blood is not absorbed or does not become organized the surrounding connective tissue as a rule tends to encapsulate it, thus creating a cyst formation. Due to special anatomical conditions, i.e., the peculiar structure and the circulatory system of bone, which allow only a slight possibility for compensatory adaptation to circulatory disturbances, bleeding into the spongiosa or corticalis of the bones of the skull is apt to produce cyst formations which result in unusual pathological and clinical pictures.

Some of these cystic conditions of the skull have been known a long time. However, they are encountered not too frequently, and present so many points of interest both from the clinical and pathological points of view that it seemed to us advisable to present three cases which seem to touch upon the problem. In two cases the cyst formation was found between the skull and the pericranium; the third case presented a cyst cavity in the diploe of the frontal and parietal bones (Fig. 1).

REVIEW OF LITERATURE

When the blood collects between the pericranium and the skull, the condition is termed a cephalhæmatoma (1). Cephalhæmatoma, or tumor cranii sanguineus of the elder authors, consists of a subpericranial blood effusion following the rupture of some of the blood vessels which run between the pericranium and the skull, and is usually due to an injury during labor.

Evans (2) has been able to produce a cephalhæmatoma artificially by mechanical pressure, and by lacerating or dividing the vessels with a tenotome. He has demonstrated this by rhythmical injection of the ruptured blood vessels with a colored preparation. Naujoks (3) experimentally produced cephalhæmatoma in a newborn and just dead infant by compressing and rubbing the sides of the head with a hard and blunt instrument, and then applying a vacuum pump. When the pump alone was applied under similar circumstances, only a circumscribed area of œdema of the scalp, the so called caput succedaneum was produced. Fissures of the bone, that is, minute linear fractures, often accompany the blood extravasation (Hamon, 4; Kustner, 5; De Lee, 6), and indeed are even thought by some to be the prevalent etiological factor in producing a cephalhæmatoma.

Such hæmorrhages may occur, however, irrespective of many factors which have long been considered as the cause of their production. They arise irrespective of the position of the fetus *in utero*, without any relation to a head or vertex presentation, and in labors in which mechanical assistance is not employed. Lastly, even a difficult adaptation of the fetal head to the maternal pelvis is often absent. De Lee (6) has seen four cases of cephalhæmatoma after spontaneous head deliveries.

There have been many suggestions to explain the apparent absence in many cases of an obvious cause for the presence of a cephalhæmatoma. Bednar (7) thought to find it in the diminished pressure upon the head of the newborn after delivery. The blood vessels, entering the skull from the pericranium, become acutely filled up with blood, the pressure of which tears their delicate walls. According to Evans (2), the injury producing the cephalhæmatoma is done during the partum, but the blood is effused later, inasmuch as when extra-uterine life supervenes upon the antenatal, profound and important changes follow in the circulatory system, in the blood pressure, and in the blood itself. The alterations in the blood pressure come on gradually, and become more and more marked as the alterations of the blood circuit through the lungs and heart occur, until about the third day the blood pressure begins

[1]From a study made in the Department of Surgery, Northwestern University Medical School.

Fig. 1. Location of cystic formations in cases of, a, ossified cephalhæmatoma (Case 1); b, subpericranial blood effusion (Case 2); c, osteitis fibrosa of the frontal and parietal bones (Case 3). Diagrammatic.

to increase markedly. It is indeed on the third day after delivery that cephalhæmatomata most frequently occur. It rarely appears before 48 hours postpartum, although in Beck's collection (8) the earliest observed cephalhæmatoma was found at the time when the opening of the uterus was not larger than 3 centimeters, and the latest appeared on the seventh day after delivery.

Keller (9) sees in asphyxia developing during the delivery an important factor in the production of cephalhæmatoma. The markedly dilated venous channels of the skull tear easily. Beside that, however, there is a change in the blood chemistry, inasmuch as the blood becomes overloaded with carbon dioxide. This explains, according to him, the fact that the blood effusion is usually dark red in color and stays fluid for long periods of time. The last feature has been observed by Virchow (10), who found the cyst content in cases of cephalhæmatomata of 4 to 6 weeks duration to be always fluid and to contain relatively unchanged red blood cells.

Contrary to what is commonly thought, cephalhæmatoma is of rather rare occurrence. Hennig (11) observed it only 230 times in 53,506 deliveries; Hofmokl (12) found it in 0.6 per cent of the 59,885 examined case reports; Beck (8), studying case records from two leading Munich maternity hospitals, found one cephalhæmatoma in 20,402 deliveries. The most frequent site of the effusion is the right parietal bone (Burchard, 13). This is apparently due to the fact that this region of the head is most frequently the presenting portion.

Unless infected, ruptured, or associated with intracranial hæmorrhage a cephalhæmatoma does not produce as a rule any clinical symptoms except for the tumefaction. The pericranium being particularly adherent to the bones at the line of suture, effusions of the blood beneath the pericranium are limited and outlined by the lines of sutures. They may be single or multiple. In 102 cases Beck (8) found a single cephalhæmatoma in 88 cases; two subpericranial effusions in 12 infants; only in one baby were there three effusions, and only in one were there more than three. In serious injuries it is possible to have beside a subpericranial effusion, an extravasation between the skull and the dura, as well as a subdural and cortical hæmorrhage (Cushing, 14).

Depending on their size, cephalhæmatomata are usually absorbed in from 2 weeks to 3 months (Olshausen and Veit, 15). The entire process of resorption may, however, be completed in 6 weeks. In rare cases, according to Cushing (14), a cystic condition may result, the hæmatoma remaining fluid in its center, clotting and organization having taken place only about the periphery; and in this state a swelling may persist throughout life. When absorption of the subpericranial blood effusion is delayed longer the swelling may, according to Virchow (10), become surrounded by a ridge of new formed bone, deposited along the elevated pericranial edge. At the same time the surface of the denuded bone also becomes the site of new bone formation. The blood effusion is slowly resorbed and when this finally occurs only a flat, uneven, exostosis marks the previous location of the cephalhæmatoma. This may sometimes lead to a permanent extracranial deformity. Potocki (16) describes such a case and emphasizes the point that there are only 4 analogous cases reported in the literature. Karewski (17), Olshausen, and Veit (15), and Keller (9) mention briefly that bone salts are sometimes deposited in the elevated pericranium, the space between the latter and the surface of the skull being filled up by a spongy bone tissue.

Lorand (18) actually reports such a case. A full term baby, normal labor, head presentation, a few days after the delivery showed a tense, fluctuating, non-pulsating, painless mass about the size of a goose-egg in the right parietal region. Eleven months later there was found in the same region a hard, immovable, painless tumor mass, covered with a freely movable normal skin. X-ray examination of the head showed a normal outline of the skull in the right parietal region over which there was a thin bone shell casting only a very light shadow and walling off a semilunar space.

It seems, however, that Hatschek (19) is the only one who actually studied the histology of such a condition. The points of importance in his splendid microscopical study may be summed up briefly. In the first case, a 17 day old girl, with a cephalhæmatoma associated with a subdural hæmorrhage in the region of the left frontal bone, the organization and encapsulation of the extravasated blood took place from the pericranium, dura, and from the denuded bone. The opened blood vessel channels of the bone were the source of the connective tissue. The greatest part of the periphery of both blood extravasations, i.e., that between the skull and pericranium and the skull and the dura mater, consisted of a layer of blood serum. The surrounding connective tissue tended to encapsulate only the hæmatoma. Organization was to be seen only where connective tissue was in close contact with fibrin and cellular elements of the blood effusions. New bone was laid down at the points of transition of the normally adherent pericranium to the elevated structure and in the dura mater over the entire surface walling off the hæmatoma.

In Hatschek's second case, a 3 months old child presented an extracranial cephalhæmatoma over the left parietal bone. The elevated pericranium had been transformed into a continuous bony shell of adult cancellous bone tissue. Bone was laid down also in the connective tissue proliferating from the blood vessel channels of the denuded bone. Consequently, the hæmatoma had been entirely walled off by a bony shell. Between the hæmatoma itself and the bony shell there was a connective tissue capsule and the metaplasia of the connective tissue into the osteoid and finally into the osseous tissue could be observed. Between the outer and the inner walls of the bony cyst, numerous partially ossified connective tissue trabeculæ divided the cavity into multiple smaller ones, thus possibly producing an ultimate healing.

The majority of the cephalhæmatomata may subside under conservative protection of the tumefaction. Virchow (10) pointed out that aspiration of blood from a cephalhæmatoma is apt to reproduce bleeding, but on the other hand, the pericranial exostosis is more pronounced in the case of conservative treatment than after evacuation of the blood. This was demonstrated by Betschler (20) who made comparative observations in cases of bilateral cephalhæmatomata in which the condition on one side was treated by aspiration, and on the other left alone. Cushing (14) advises waiting for about 2 weeks, and if then there are no signs of subsidence he incises and evacuates the clot. Potocki (21) advises puncturing the cephalhæmatoma if it is large and if it is absorbing slowly, and then to compress the empty cavity with adhesive strips. Christopher (22) emphasizes that the "let alone" treatment is not without peril, as the development of infection is likely to occur in cephalhæmatomata of long standing (Vaughan and Burnham, 23).

Although cephalhæmatoma has been observed most frequently in newborn nfants, there are a few reports of the occurrence of the subpericranial blood effusion in older chi dren. Friedmann (24) observed this condition three times during the 23 years of his experience. In 2 children, 2 and 4 years old, respectively, a cephalhæmatoma had occurred without obvious reasons, being discovered accidentally during combing of the hair. In the third case, that of a boy 8 years old, there was a definite history of trauma 1 week previous to discovery of the cephalhæmatoma. In all these cases the hæmatoma was limited and outlined by the lines of sutures, being absorbed in from 8 to 14 days, leaving behind it the well characterized bony ridge. Francois (25), Stolzner (26), and

Hohlfeld (27) have reported similar experiences and emphasized trauma as the etiological factor.[1]

Von Recklinghausen (28), in describing the generalized disease of the skeleton, termed by him osteitis fibrosa, reported that in the fibrous areas replacing the bone marrow regressive and progressive changes may take place. The first, which he related to liquefaction-necrosis of the connective tissue, result in formation of cysts, occasionally multilocular, lined with smooth walls and containing a serous or thick fluid. They were observed by him chiefly in the long bones of the skeleton and only once in the skull. The progressive changes give rise to the formation of so called giant cell tumors, i.e., solid, brown tumors composed of numerous, multinuclear, giant cells in a spindle cell matrix containing deposits of hæmosiderin.

Schmidt (29) first called attention to the evidence that a solitary bone cyst may accompany or be the result of a localized osteitis fibrosa. Beneke (30), discussing a case reported by Monckeberg, expressed the view that bone cysts may be the result of a trauma and follow an intramedullary hæmorrhage. He conceived them as analogous in origin to the apoplectic cysts of the brain.

It has been shown experimentally by Bajardi (31), Haasler (32), and Enderlen (33) that a blood effusion into the bone marrow calls forth a reactive proliferative process. Konjetzny (34) confirmed their results and from his histological preparations could demonstrate how an intramedullary hæmorrhage produces a reactive proliferative process of the bone marrow. The product of this proliferative process, which can be compared to granulation tissue, consists histologically of all the elements encountered in lesions known as osteitis fibrosa. The clinical course, the radiological and the histological findings are very closely related to those of giant cell tumors. Frequently in the course of the disease one encounters formation of cysts. In turn, hæmorrhage into the cysts may lead to an overgrowth of masses, resembling granulation tissue, which may enlarge and finally be recognized as a giant cell tumor. In the course of the natural life of this granulation tissue there is a stage of differentiation when fibrous tissue, osteoid, and sometimes osseous tissue form after the blood clot becomes organized, and all the foreign elements have disappeared (Kolodny, 36). Lubarsch (37 b) supported this view of the so called giant cell tumors as being a "chronic resorptive process."

Felten and Stolzenberg (38), who found trauma as the etiological factor of the localized osteitis fibrosa in 81 per cent of the reported cases, cite an instance of a bony cyst in which the initial trauma, in the form of a small piece of metal, destroyed the spongiosa with a resulting blood effusion. Fujii (39) believes that solitary bone cysts may be either the result of osteitis fibrosa or may be due directly to an intramedullary hæmorrhage. Observing a bone cyst in a boy suffering from a hæmophilia-like condition, he emphasizes the point that the fluid blood filling up the cyst cavity does not allow the organization of the blood effusion to take place, and by continuous pressure upon the surrounding bone tissue produces its atrophy, thus enlarging the cyst cavity. Barrie (40) has reproduced the so called giant cell tumor experimentally by embedding a piece of sterile gauze in the bone marrow, and he agrees with Mallory (41) as to the origin of giant cells in these conditions.[2] He believes that they will be found whenever a suitable irritative agent is present. The hæmorrhage is, according to him, an essential part of the production of the giant cell growth.

[1] Here belong, most likely, some of the cases reported in the literature under the name of "sinus pericranii" (Stromeyer, 35). Under this and other terms have been reported traumatic collections of fluid blood under the pericranium, the extracranial sac communicating with one of the dural sinuses either directly or through a venous channel. The pathology of this condition is not unique, however, the "sinus pericranii" representing therefore rather a symptom complex than a pathological entity.

[2] Mallory (41) maintains that the giant cells of the so called giant cell tumors are similar to osteoclasts of normal bone and are due to the fusion of endothelial leucocytes attracted into the tumor by the presence chiefly of lime salts, fatty acids, and cholesterine crystals. They are foreign body giant cells. The very intimate relation of the giant cells to the vascular endothelium, the frequent lining of blood spaces by giant cells, and the tracing of the formation of giant cells to the proliferative vascular endothelium seems, according to Kolodny (36), to support Lubarsch's (37) view of the giant cells as abortive vascular sprouts. Johnson's (42) observations on 11 specimens of benign giant cell tumors of bone seem to show conclusively that the giant cells in these lesions arise from the endothelium of the blood capillaries. Aside from these giant cells no cells occur in these lesions which are not met with in ordinary inflammatory processes. Lubarsch (37 a), Konjetzny (34 a), Stumpf (43), Frangenheim (44 b) deny the term of a blastoma of the so called giant cell tumors because of the absence of multiformity in the size of the cells and nuclei, predominance of the stroma over the cellulary elements of the tumor, successive differentiation of the cellulary areas, absence of metastases, etc.

Pommer (45), studying the cyst contents and the tissues surrounding a cyst of the humerus, established direct proof of the hæmatomatous character of some, at least, of the solitary bone cysts. The results of his investigations may be summed up as follows: The pressure of hæmorrhage upon the veins of the spongiosa produces a stasis of the tissue fluids, which causes the liquefaction of the blood content of many of the cysts and œdema of the tissues in the immediate vicinity. The localized areas of loose fibrous tissue replacing the bone marrow in the vicinity of the cyst are effects of the congestion and irritation produced by the hæmorrhage. The resorption of the surrounding bone, leading to the enlargement of the cystic cavity, the fibrosis of the bone marrow, and new bone formation are therefore secondary results of the pressure from hæmorrhage and increased transudation.[1]

Schuster (48) cited a case of a large bone cyst occurring at the site of trauma with hæmorrhage into the bone marrow. He considers the origin of the cyst in his case as purely traumatic and gives the following differential points against a cyst formation resulting from osteitis fibrosa: the bone marrow around the cyst was found to be normal; osteoclasts and giant cells were exceedingly scarce; there was no new bone formation and there were no hæmosiderin deposits found beside foci of fresh hæmorrhages.

Pommer's (45) point of view on the pathogenesis of solitary bone cysts and osteitis fibrosa is upheld and confirmed by Konjetzny (34 b) and Looser (49 b). Osteitis fibrosa and the so called giant cell tumors on one side, and the solitary or multiple bone cysts on the other are two forms of reaction of the bone tissue to one cause, i.e., hæmorrhage. Bleeding into the corticalis of the bone is more likely to produce a bone cyst as its ultimate outcome, whereas pictures of an osteitis fibrosa or giant cell tumor (the last in older individuals) will be found more frequently in cases of intramedullary bleeding (Fig. 2). These conditions representing, broadly speaking, a mechanically produced pathological symptom complex, will be found in normal bones as well as in bones already affected by various systemic diseases (Looser, 49 a; Lang, 50 a, b, c). Very slight traumatism is frequently sufficient for the appearance of medullary hæmorrhage. It is probable that fissure fractures or infractions with rupture of nutrient vessels will lead to them.[2]

Nissen (51) experimentally destroyed the bone marrow in animals submitted to parabiosis and produced histological pictures analogous to those of osteitis fibrosa. First, the blood effusion became encapsulated by a thick connective tissue wall; then, when the parabiosis was interrupted, the cavity became filled in with connective tissue which ultimately became ossified. The surrounding bone tissue showed pictures resembling those of osteitis fibrosa. He thought the reason for the cystic formation was connected with the hypocoagulability of the blood of the animals under parabiosis. Mandl (52) introduced a 1 per cent solution of sodium citrate into the bone marrow and injected it also intravenously. He has been able to produce in this way definite cyst cavities in the bone, concluding that the hypocoagulability of the blood, after trauma, is the reason for cyst formation in the bone.

Geschickter and Copeland (53) consider the solitary bone cysts as a form of osteitis fibrosa. In their large collection of solitary bone cysts, 2 per cent of the cases could be shown to have a bone destructive phase due to a foreign body or abscess and in about 20 per cent of the cases, rather loosely classed as osteitis fibrosa, some primary disease such as osteomalacia, osteitis deformans Paget, fragilitas ossium, or osteo-arthritis were responsible for this formation. However, 78 per cent showed their rela-

[1]Actual chemical and microscopical examination of solitary bone cyst contents made by Pfeiffer (46) revealed a bile-like color, showing an intensive bilirubin reaction with iodide and sulphuric acid. Rare erythrocytes were found in the sediment. The fluid had a very high hæmatoidin content and was rich in proteins. According to Bloodgood (47), the fluid content of the cysts is never distinctly hæmorrhagic; it is usually thin, dark brown in color, and contains under the microscope blood pigment and blood cells. There may be a few blood coagula in the fluid sticking to the bone shell, or attached to the connective tissue lining there may be red, blood stained masses which under the microscope show organized blood clot and pictures of osteitis fibrosa. Giant cells have been found in a few cases in this organized blood clot, but more often they are found near the bone shell.

[2]This would explain the fact that trauma, in the usual sense of the word, is not necessarily the only etiological factor in producing a blood effusion in the bone. Intracortical or intramedullary hæmorrhage might be the result of "physiological" trauma, i.e., trauma of daily life. It must be kept in mind, of course, that not necessarily all the cystic formations of the bone, or osteitis fibrosa and giant cell tumors, are the result of trauma and hæmorrhage.

tionship to a preceding giant cell tumor phase. More broadly stated, the average solitary bone cyst in the long bones is, according to them, a healed or healing giant cell tumor. Twenty-nine early cases of bone cysts in their collection showed marked giant cell areas, and 60 cases of giant cell tumor of a series of 226 cases show a healing change toward osteitis fibrosa. They are in accord with Konjetzny (34 a), Lubarsch (37 b), and Pommer (45) in placing trauma in a primary position in the production of the bone cysts and giant cell tumors. Based, however, on the embryological observations of the development of the blood supply of the long bones, they attempt to explain the production of these lesions in the following way. Trauma acts on the cortex of the bone in relation to its periosteum, avulsing the latter and interrupting the blood supply of the cortical bone. Normal vascular channels are thus supplanted by a subperiosteal hæmatoma. Interruption of periosteal blood supply renders inactive the cortical bone and its normal healing powers are suspended. The medullary circulation in this region must take on an increased activity and by establishing new channels must work its way around the injured area to undertake the work of repair. This increased function of the medullary blood supply during the interruption of the periosteal circulation can take place only after osteoclasts have opened up the channels in bone for the budding capillaries. This increased osteoclastic activity occurs where osteoclasts are already unusually active in absorbing bone, and at the time when unnourished cortical bone is undergoing necrosis. An imbalance is thus created between bone destruction by osteoclasts and new bone formation that would normally proceed from the reactive cortex were its circulation intact. This imbalance results in an unchecked hyperplasia of the osteoclasts and produces a tissue characteristic of giant cell tumor and the early phase of osteitis fibrosa or bone cysts.

Osteitis fibrosa[1] and bone cysts are very rarely found in the skull. In a series of 50 cases of the first condition published by Bloodgood (47), there were none occurring in the skull. Geschickter and Copeland (53), reviewing the records of the surgical laboratory of the Johns Hopkins Hospital extending over a period of 35 years found that in the purely membranous portions of the calvarium (the frontal and parietal bones), not a single instance of these lesions has been recorded. In the 114 cases tabulated as "typical bone cysts" none was located in the skull. Indeed, they are not frequent as judged by the literature of the subject. Cases of osteitis fibrosa of the vault of the skull, more or less cystic, have been reported by Wrede (54), Frangenheim (44 a), Krogius (55), Kolbe (56), Petrow (57), Torndorf (58), Looser (49 b), Ehrlich (59), and Palmer et al (60). Cases of this condition, but without cyst formation were recorded by Boit (61),

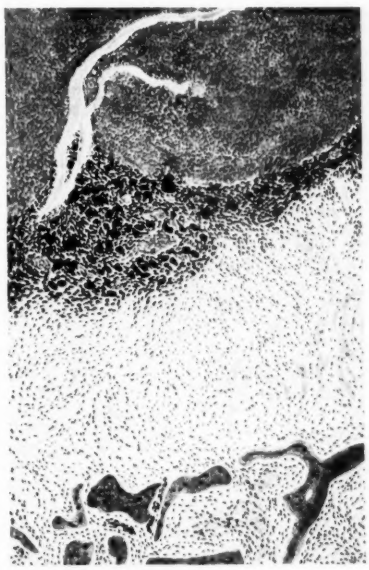

Fig. 2. Limitation of a hæmatoma. Blood coagulum with partly shrunken blood red corpuscles. Rudiments of hyalinized tissue septa are found in the coagulum which next is limited by an area rich in spindle and giant cells. One giant cell is seen to expand bud-like into the blood coagulum. Multiple, cilated blood vessels in the cellular area. Gradual, continual, differentiation of the cellular area into an acellular, fibrous connective tissue, with formation of osteoid tissue and partly calcified bone lamellæ. Schematic drawing after actual observation. (From Konjetzny.)

[1]Excluding osteitis fibrosa of the upper and lower jaw, temporal fossa, and the epulis of the alveolar border.

Therstappen (62), Herfahrt (63), Stenholm (64), Fraser (65), and Meyer (66). Osteitis fibrosa of the skull as a part of a more or less generalized osteitis fibrosa has been observed by Haberer (67), Kolaczek (68), Dreyer (69), Wanke (70), and others.

The age incidence is from 6 to 42 years in the reported cases. The process usually starts, however, in the early teens. The frontal bone is the most frequently quoted site of involvement; then follows the temporal, and finally the parietal and occipital bones in equal numbers. Involvement of more than one of the bones of the vault of the skull, in adjacent areas, has been observed.

Trauma seems to be the most important etiological factor and is more or less closely related to the first appearance of the symptoms in the majority of cases. Petrow (57), in whose cases the blood vessels of the pericranium and of the haversian canals were found occluded by thrombi or hyaline degeneration of their walls, believes the etiological factor for the osteitis fibrosa in his cases resided in the pathological condition of the blood vessels, which could have been produced by infectious, toxic, or traumatic causes. Ehrlich (59), reporting a case of osteitis fibrosa cystica of the frontal and temporal bones attempted, because of the patient's history of frontal presentation at birth and the existence of the condition from early childhood, to attribute the etiology to trauma sustained at birth. Palmer et al (60) observed a case of a 14 year old girl diagnosed clinically as osteitis fibrosa cystica of the occipital region resulting from a fracture of the skull at the age of 26 months. At the operation (Dr. Charles H. Frazier) a large cyst was found in the diploe of the occipital bone 2.5 centimeters thick in its center, projecting inward and tending to compress the brain beneath it. The dura and the pia mater beneath the cyst were markedly thickened, and there were adhesions of the dura to the cyst wall. Because the patient showed evidences of hypothyroidism and hypopituitarism, they expressed the opinion that it may be conjectured that there are conditioning endocrine factors in patients who develop cystic bone lesions following trauma, resulting in a disordered metabolism and predisposing to anomalous repair with typical cyst formation. Nonne (71) points out, however, that endocrine disorders are absent in the majority of reported cases, not only of localized osteitis fibrosa, but also of the generalized form of this condition.

The clinical picture is that of more or less large tumefaction[1] the consistency of which may be bony or soft. The surface is either smooth or uneven. The tumor is painless on pressure or palpation, the soft tissues of the scalp are not involved, the skin is unchanged, normal in color and freely movable over the tumor. Complaints, if present at all, are due to compression of various cranial nerves or cerebral centers. Among the more severe neurological manifestations may be found headaches, seizures of the Jacksonian type, and paresis in the extremities (Frangenheim, 44 a), disturbances of vision, hearing and taste, paresis of the occulomotor and facial nerves, as well as paræsthesias in the distribution of the trigeminal nerve, nausea, and a variety of psychic symptoms (Ehrlich, 59), hemianopsia and visual hallucinations (Palmer et al, 60). As a rule, however, the pathological process of the bone extends toward the outside of the skull, and signs of increased intracranial pressure as well as other neurological symptoms are absent.

Corresponding to the tumefaction of bone, the X-ray examination shows a more or less distinctly outlined shadow composed of lighter and darker areas. The bone surrounding the lesion is thinned or sclerotic. Except for the case of Fraser (65), in which the lesion (a so called giant cell tumor) destroyed the internal table of the skull and filled in the extradural space, the two cortical tables are generally intact. The ballooned diploe extends usually outward, except for the cases of Wrede (54), Boit (61), Ehrlich (59), and Palmer et al (60) in which there was also an intracranial expansion. In Petrow's (57) and Palmer's (60) cases the lesion was entirely cystic on X-ray examination.

Gross pathology reveals the affected bone to be greatly thickened or thinned. It is

[1]Frangenheim (44 a) considers that only in a case of a combined, diffuse tumefaction of the bones of the skull and of those of the face should the term of leontiasis ossea Virchow be used.

oftentimes difficult to make out the tables of the bone, but when well outlined they may show a normal thickness. The diploe is filled out either with fibrous masses, yellow or brownish in color, or by a spongy bone tissue showing here and there patches of sclerosis. The fibrous areas are easy to cut through and give the tumor its soft consistency.

In some of the cases more or less distinct cyst formation was reported, described by some as a blue dome. The cyst or cysts may be about the size of a cherry to an apple, or larger. The gross pathology of the larger cysts (Petrow, 57; Torndorf, 58; Palmer et al, 60) is that of a bony tumor representing, according to the duration of symptoms, a more or less thick bony shell. A connective tissue capsule is found beneath the bony shell, adhering very closely to the bone and entering its enlarged canals. Further, toward the interior is the cavity containing fluid, light red blood, serous fluid or jelly-like masses. In Petrow's (57) Case 1, the capsule of the cyst consisted of dense fibrous layers with islands of round cells and many blood pigment deposits, beside areas of fresh hæmorrhages. Blood vessels showed hyaline degeneration. The surrounding bone tissue presented pictures typical of an osteitis fibrosa. The cyst contents were rich in erythrocytes with only very rare leucocytes. Similar was the composition of the cyst wall in Torndorf's (58) case.

In the solid forms of osteitis fibrosa the microscope reveals new bone formation and bone destruction. According to descriptions found in the literature, fibroblasts are seen to change into osteoblasts and finally form osseous tissue, although sometimes only the osteoid phase of the process is attained. Bone destruction takes place by osteolysis and by action of osteoclasts. Hæmatoblasts and fat cells disappear from the bone marrow and the connective tissue, which may be either fibrous or very vascular and rich in cells, fills up the channels of the bone marrow, the haversian canals of the corticalis and the lacunæ produced there by osteolysis. Round cells and plasma cells will be found frequently in this connective tissue. Here and there giant cells, resembling the osteoclasts, are scattered throughout it, but chiefly at the periphery of the lesion. Pathologically the process starts with bone destruction, then comes to replacement of the bone marrow by the fibrous tissue which may ultimately lay down new bone. The relationship of bone production and bone destruction varies, however, and it may come to a cyst formation.

Fig. 3. Photograph of patient described in Case 1 showing the tumor mass below the posterior fontanelle and over the suboccipital ridge.

The process is sometimes apt to recur. In Boit's (61) case, the condition recurred in the same region about 5 years after the first operation, presenting pathologically an identical picture. In the case reported by Dreyer (69), the process recurred twice. In spite of that, the prognosis seems to be good. Gold and Schlesinger (72) emphasize that the transition of a localized form of osteitis fibrosa into the generalized has not been encountered. Boit (61) made a roentgenological examination of the entire skeleton 10 years after the condition had been diagnosed and operated upon in the skull and found it entirely normal. Two years after the second removal of the solid tumor, he could demonstrate a filling in of the bony defect by a new bone formation. In Palmer's (60) case, the mental changes subsided after the removal of the cyst to a noteworthy degree, and the hallucinations disappeared entirely.

The treatment of choice is the surgical removal of the pathological process by curettement in the cystic form, or resection of the

Fig. 4. Roentgenogram of skull of patient described in Case 1. Note bony shell covering the tumor mass.

Fig. 5. Roentgenogram of skull of patient described in Case 1 following operation.

invaded portion of the bone in the solid form. Good results are reported even after the most conservative surgical procedure (Krogius, 55). Recurrences should be reoperated upon (Boit, 61; Dreyer, 69). The large bony defects may be covered by bone transplants (Wrede, 54; Frangenheim, 44 a). As a rule the postoperative recovery is very good. The mortality has not been recorded.

REPORT OF CASES

Case 1. S. R., No. 8613 (P), a male infant, 7 weeks and 2 days old, was admitted to Passavant Memorial Hospital on November 29, 1931, referred by Dr. Edward L. Cornell who delivered the baby. The newborn was the first pregnancy and delivery of his 29 year old healthy mother was at full term by normal labor with an occipital presentation. It had shown a tumor mass, the size of an egg, in the occipital area since birth which was diagnosed as caput succedaneum. The mass did not seem to cause the child any discomfort and according to the mother enlarged only in the past few weeks. Physical examination showed an apparently healthy infant, presenting a tumor mass below the posterior fontanelle and over the suboccipital ridge (Fig. 3). It was about 8 to 10 centimeters in diameter and about 5 centimeters high. It was hard and firm on palpation, immovable, non-pulsating, and the scalp which showed no discoloration or any inflammatory signs was freely movable over it. The mass did not seem to be tender on palpation or pressure. The anterior fontanelle was widely open, the parieto-occipital suture line was very prominent but the skull otherwise was normal. On the X-ray films the skull tables appeared normal. There was no evidence of a bony defect (Fig. 4). The palpable mass had a definite bony shell covering, and its contents showed little or no shadow. Neurological examination of the baby was entirely negative. Urinalysis was negative. Erythrocytes, 4,940,000. White blood cells, 9,800. Hæmoglobin, 78 per cent (N). Bleeding time 5½ minutes.

At the operation a semilunar incision was made through the scalp above the superior margin of the tumor mass. The scalp and pericranium were reflected downward off the mass whose surface was rather rough. Its edges became confluent with the rest of the skull in a smooth, gradual manner. A burr hole was placed in the apex of the tumor mass, and a thin egg-shell like layer of bone was broken through. The contents of the tumor appeared to consist of thick, brownish, syrup-like fluid which was contained in a multilocular cystic cavity. There was a thick membrane inside the bony shell which was adherent to the inner surface of the bone. The covering of the cyst was rongeured away down to the level of the external table of the skull. After it had all been removed the remaining membrane which was attached to the base of the cyst, or the external table of the skull, detached very easily. The external table of the skull appeared then like mosaic-tile work, and was thinned in two areas which would have required very little to have exposed the dura. The pericranium and scalp were sutured with black silk. The baby made an excellent postoperative recovery, being discharged from the hospital 3 days after the operation. X-ray examination of the skull, made 3 weeks later, showed the result of the operation to have been satisfactory; the skull was intact and the tumor consisting of the bony cyst was absent (Fig. 5).

Microscopic examination of the specimens removed at operation, i.e., the bony shell of the cyst and the capsule lining of the cyst cavity revealed the following: Sections cut through the bony piece

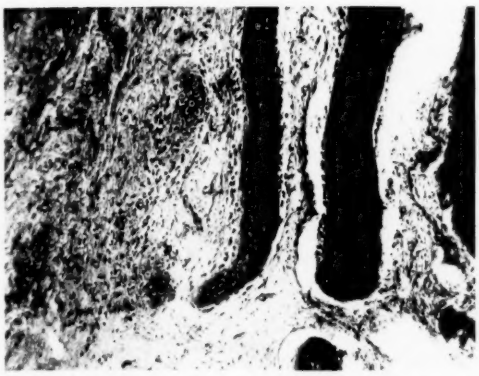

Fig. 6. Case 1. Osseous tissue lamellæ with rows of osteoblasts surrounding them. Hæmatoxylin-eosin stain; ×85.

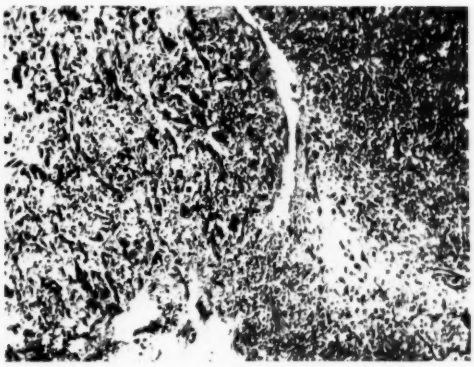

Fig. 7. Case 1. Blood effusion in process of organization. Hæmatoxylin-eosin stain; ×45.

show the presence of numerous osseous tissue lamellæ, separated one from the other by strands of loose, young connective tissue (Fig. 6). Single or double rows of osteoblasts surround the adult osseous lamellæ. The more peripherally situated lamellæ, stained red with eosin, show multiple foci of blue colored osseous tissue. In many places spindle-like cells of connective tissue are seen to condense and at these points a reddish stained, amorphous substance is laid down. These places represent, here and there, direct prolongations of the bony lamellæ. These osteoid and osseous tissue formations are in close contact with dense, fibrous, almost acellular layers of connective tissue, which at rare places show a more œdematous character. Sections cut through the cyst wall tissue reveal patches of more adult fibrous connective tissue and portions where there is an abundance of young fibroblasts and capillaries energetically organizing the blood effusion which lies in the center of the cyst cavity (Fig. 7).

Diagnosis: Ossified cephalhæmatoma of the occipital region.

Roentgenologically, the case resembles that reported by Lorand (18) which, however, was not operated upon and verified histologically. The complete absence of a history of an obvious trauma during the delivery or of any systemic causes which could explain the occurrence of the cephalhæmatoma is noteworthy. It should be pointed out, however, that the lesion was situated in the occipital region which was the leading portion of the head at delivery and that consequently a traumatic origin of the cephalhæmatoma in this case is most likely. Microscopically, the case is similar to those studied histologically, on autopsy material, by Hatschek (19).

From specimens obtained piecemeal at the time of operation, it is difficult, to reconstruct beyond doubt the actual pathogenesis of a given lesion. It may be, however, reasonably assumed that the sequence of events in our case was the following: Due to an injury sustained during the delivery, or after, there was a rupture of blood vessels running between the pericranium and the skull with an effusion of blood between the external table of the skull and the pericranium. Encapsulation and partial organization of the blood effusion followed. It could not be demonstrated where the process of ossification of the outer layers of the hæmatoma actually started, but the presence of blue colored inclusions of osseous tissue—which feature is accepted as sign of its primitiveness—in adult, red stained bony lamellæ, situated more peripherally from the hæmatoma, points toward the pericranium as the origin of the process. This would be in accordance with the findings of Hatschek (19), who has been able to demonstrate that the very beginning of the process of ossification in his cases of cephalhæmatoma was in the pericranium at the points where it had been separated from the bone. The process of ossification of the cephalhæmatoma would start, therefore, in the deep layers of the pericranium, the external layer persisting in its dense fibrous structure, as evidenced at the time of operation.

Noteworthy is the fact that the hæmatoma was entirely walled off on its outside surface in our case of a 7 weeks old baby. This is analogous to Hatschek's second case, that of a 3 months old child. This author demonstrated, however, the beginning of a distinct new bone formation in a case of cephalhæmatoma of a 17 day old infant (Case 1).

The surface of the external table of the skull, forming the base for the cephalhæmatoma, appeared at the time of operation like mosaic-tile work and was thinned in two areas. It might be conjectured that this was due either to pressure of the large hæmatoma or to direct disturbance of nutrition of the bone lacking its normal blood supply after separation of the pericranium over an area of about 10 centimeters. Necrotic bone changes in cases of cephalhæmatomata were noted by Michaelis and Paletta as quoted by Quirel (73).

As pointed out above, ossification of the entire elevated pericranium in cases of cephalhæmatoma is of rare occurrence, as is the ossification of the elevated periosteum in cases of subperiosteal hæmatomata elsewhere in the body. Such cases have been described by Deetz (74) as an ossified hæmatoma of the pelvis; by Glimm (75), who reports such a condition in the tibia; and by Cone (76) in the humerus. The last case presented histologically the characteristics of a so called giant cell tumor and the author states that the cases of osteitis fibrosa in his collection like those described by others, exhibit the same pathology as the ossifying hæmatoma, differing only in the location of and the amount of bone involvement.

Case 2. No. 128922 (W). L. M., aged 26, married, was admitted to Wesley Memorial Hospital on December 14, 1926. About 4 weeks previous to admission the patient stated that while washing her head, she noticed a slight "lump" over the right frontoparietal region of the scalp. This was followed in a few days by a swelling on both sides of the scalp, extending from about the occipitoparietal sutures to the frontal area about 2 centimeters above the eyes anteriorly. In 4 days' time the swelling spread over the right cheek, almost closing her right eye. The swelling then gradually receded in about a week, except that the "lump" in the scalp remained. The present tumor mass had remained practically the same for the last 4 weeks, except that it had been somewhat smaller in size for the last 6 days because it was incised. Her local doctor told her that he obtained "a little watery fluid." The generalized "swelling" of the head was accompanied by a dull headache, but there was no accompanying temperature and the patient says she did not feel ill. About 1 month previous to the accidental discovery of the lump over the right frontoparietal region, while moving and arranging her furniture, the patient sustained repeated injuries to her head. Otherwise the past history was essentially negative. The general physical and neurological examination revealed no abnormalities whatever. The patient was fever free, the lymph nodes of the neck were not enlarged. In the right frontoparietal region of the skull there was a fluctuating mass about the size of a walnut. The mass was not pulsating, and no bruit was heard over it. It was painless on palpation and pressure. Change in posture of the head, coughing, or straining did not cause an increase in size. The skin, showing no evidences of inflammation, moved freely over the area. Laboratory findings (urinalysis, blood count) were essentially negative. X-ray films of the skull showed a defect in the external table of the skull circular in outline, approximately 2 centimeters in diameter, located at the right frontoparietal suture (Fig. 8A). There was no proliferation of bone at the edges of the defect; its boundaries were smooth and there was no appearance of invasion of the bone at its outer limits. The inner table was apparently intact. There were no veins running into this space. The defect had the appearance of pressure necrosis of the external table. An extra cervical vertebra was noted lying between the second and third cervical vertebræ.

Under local anæsthesia, a curved incision with a scalp flap about 8 centimeters in diameter was made, with the base directed anterolaterally. Immediately after the incision was made through the pericranium a small quantity of dark clotted blood escaped. By raising the pericranium further from the skull it was discovered that evidently the incision through the pericranium cut through a cyst wall, filling a depression in the external table of the skull. This depression was smooth. The cyst wall, which was thin and somewhat fragile and bloody, was removed completely from the bony floor and from the pericranium. Eroding through the external table was a large diploic vein. The bony excavation was curetted thoroughly. After complete hæmostasis and closure of the wound a dressing was applied, which tended to force the occipitofrontalis muscle into the bony excavation. The patient made an uneventful postoperative recovery, being discharged from the hospital 9 days after operation. When seen 2 years later, she was in excellent physical condition, and the X-ray examination of the skull showed a distinct filling in and regeneration of bone at the margin of the defect. The appearance suggested a marked improvement in the condition (Fig. 8B). The patient was seen last in May, 1933. X-ray examination of the skull did not show any-

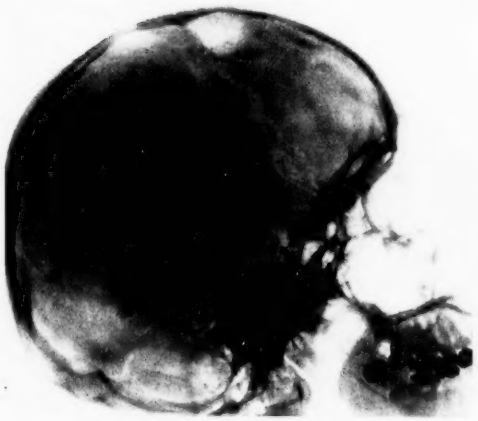

Fig. 8A.

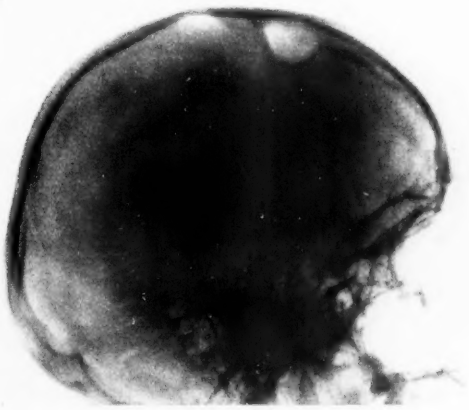

Fig. 8B.

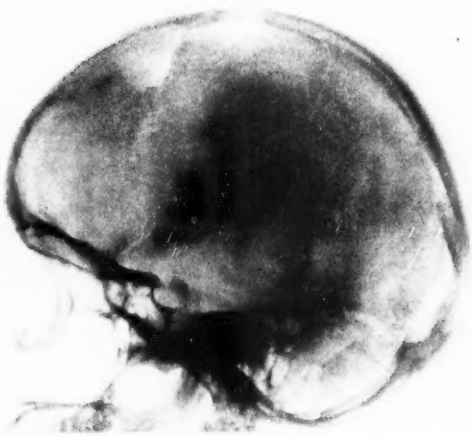

Fig. 8C.

Fig. 8. A, Roentgenogram of skull of patient described in Case 2. Note the circular defect in the external table near the frontoparietal suture line. B, Roentgenogram of the skull taken 2 years later showing distinct regeneration of bone at the margin of the defect. C, Roentgenogram taken 7 years later showing progressive diminution in the size of the bony defect.

thing pathological except for the persistence of the bony defect, although of a much smaller diameter (Fig. 8C). The blood Wassermann was negative, blood calcium was 10.0 milligrams per 100 cubic centimeters of serum; blood phosphorous 2.35 milligrams per 10 cubic centimeters of blood, and the patient had no complaints whatever.

Microscopical examination of the cyst wall removed at the operation showed the membrane to consist of fibrous connective tissue with considerable amounts of red cells and large quantities of hæmosiderin deposits (Fig. 9) scattered throughout the stroma. This blood pigment was partly extracellular but some of it had been taken up by large compound granular corpuscles. Many lymphocytes and some plasma cells were found in the tissue both in the form of perivascular infiltration (Fig. 10) and of loose infiltration of the connective tissue stroma. No polymorphonuclear leucocytes were seen. The tissue was not abnormally vascular. No endothelial lined cavities were seen in the sections, and the cyst wall margins were without any definite lining membrane. There were no tubercle formations, and no dermoid and parasitic structures were seen.

Diagnosis: Encapsulated cephalhæmatoma, complicated by a secondary infection.

The clinical and pathological picture of this case may appear somewhat obscure. Summing up the salient points of the case one sees that there is a definite history of trauma preceding the accidental disclosure of a "lump" in the right frontoparietal region. The disclosure of this lesion was followed a few days afterward by a massive swelling of the scalp on both sides which reached even the right cheek. The appearance of the massive swelling which receded in 1 week was unaccompanied by a rise of temperature or any other serious systemic reaction, except for a dull headache. Previous to admission of the patient to the hospital, the "lump" was incised and it was found at that time to contain a small amount of watery fluid. At the operation a cyst was encountered, located between the skull and pericranium, containing masses of dark clotted blood. Micro-

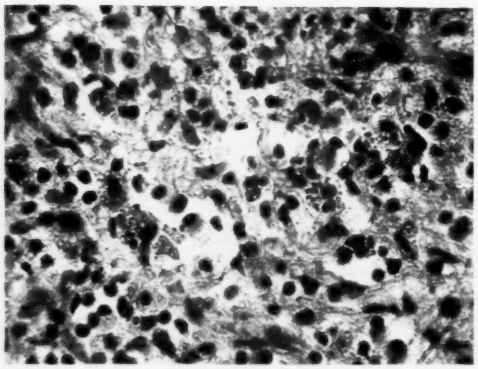

Fig. 9. Case 2. Hæmosiderin deposits in an area of lymphocytic infiltration. Hæmatoxylin-eosin stain; ×700.

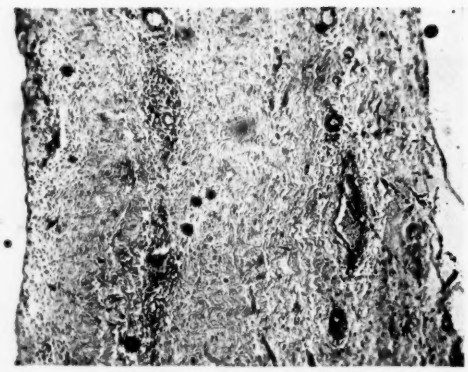

Fig. 10. Case 2. The general structure of the cyst wall. Perivascular infiltration. Hæmatoxylin-eosin stain; ×70.

scopical examination of the cyst wall showed the presence of fibrous connective tissue with a considerable amount of hæmosiderin deposits scattered throughout the whole of the stroma. There was also an infiltration of the tissue by round cells and plasma cells, polymorphonuclear leucocytes being absent. The external table of the skull underlying the cyst was found excavated.

The pathological condition in this case could be assumed as having had the following development: Small but repeated traumas to the head produced a blood effusion between the skull and pericranium. This extravasation became encapsulated in a connective tissue wall, as evidenced by the presence in it of large quantities of blood pigment deposits. Following the disclosure of the lesion by the patient a mild inflammation of some of the loose layers of the scalp occurred—most likely of the subaponeurotic space—which, subsiding clinically, left behind it its histological manifestation in the form of the above mentioned round cell and plasma cell infiltration. We have been unable to demonstrate the nature of this inflammatory process, superimposed on the hæmatoma formation; but we feel rather sure that based on the patient's history, physical and neurological as well as laboratory findings, one can exclude such pathological conditions as syphilis, tuberculosis, or parasitic conditions.

The presence of hæmosiderin deposits in the cyst wall, showing no abnormal vascularity and no retrograde changes in its stroma, speaks against the assumption that the cyst formation and the blood pigment deposits were the results of degenerative and hæmorrhagic changes in an already pre-existing pathological lesion.

The dark clotted blood masses found in the cyst cavity at the time of operation were most likely the result of the trauma of the incision into the cyst. Only a serum-like fluid was obtained at that time. Indeed, if the clotted blood came from the original trauma, one would be at a loss to explain why the hæmorrhage was not organized instead of being encapsulated. The presence of the serous fluid in the cyst cavity, on the other hand, is in accord with many observations that organization of a hæmatoma does not take place when connective tissue comes in contact with blood serum.

The depression in the external table of the skull underlying the cyst formation was due probably to a pressure necrosis. For this possibility and against the assumption of a primary bone lesion was its smooth surface, the absence of any pathological manifestations at its borders, distinct filling in and regeneration of bone after the cyst had been removed, and the present excellent condition of the patient as well as the negative X-ray examination of her skull.

The subaponeurotic tissue of the scalp—which was in our opinion the site of the inflammatory process—is of very loose tex-

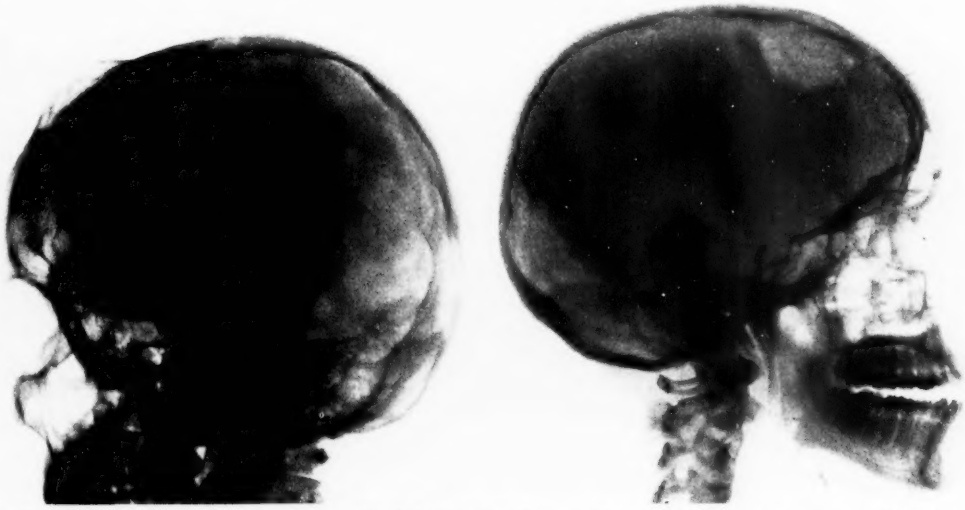

Fig. 11. Roentgenograms of skull of patient described in Case 3. Note the honeycomb appearance of the bone and separation of the external and internal tables.

ture and permits the effusion of blood or serum to spread without difficulty over a considerable area of the scalp. The limits of this spread may be posteriorly to the superior curved line of the occipital bone, anteriorly to a little above the eyebrows, and laterally to a level somewhat above the zygoma (Piersol, 77).

Zamazal (78), Stembo (79), and Rightor (80) have reported massive swellings of the entire scalp, due in their cases to a subaponeurotic blood effusion. It is noteworthy that the effused blood may stay in this fluid condition for longer periods of time. Rightor (80) reports the case of a boy, 10 years of age, who developed a swelling of the entire scalp 1 week after a head injury. Aspiration of the fluctuating, painless mass removed a quart of fresh blood. Three weeks after the injury a pint of blood was aspirated, and 1 week later still 4 ounces of fluid blood were drawn off.

Case 3. No. 133807 (W). T. H., aged 21 years, male, was admitted to Wesley Memorial Hospital on September 5, 1927, stating that he was perfectly well until about 1919 when he accidentally discovered a "lump" on his forehead. No particular occurrence called his attention to the presence of this tumefaction. Since he first noticed it, the mass had been growing very slowly and steadily until it had attained after 8 years its present size. It was smooth, well circumscribed and bony in hardness. The patient complained of nothing else except the size of the mass. When 6 years of age he sustained his first head injury by striking the head on a playground apparatus; at the age of 14 he struck his head in a fall; and 1 year previous to admission he sustained a severe injury to his head while diving. After the last trauma he was unconscious for a short time.

The physical and neurological examination of this well nourished and well developed young white male was essentially negative. The internal organs were found in normal condition, especially there was no enlargement of the spleen and no adenopathy. Over the left frontal region and slightly lateral from the median line there was a smooth, circumscribed bony prominence. This mass was about 5.5 centimeters in diameter and about 1.5 centimeters higher than the rest of the skull. There were no areas of softness in it, and nothing resembling fluctuation. It was not tender; no pulsation was present and no bruit could be heard over the mass or at its periphery. There was a very slight dilatation of a vein running laterally from this mass toward the temporal region. On X-ray examination of the skull the mass appeared to be made up of alternating areas of increased and decreased density so that it gave the appearance of being honeycombed (Fig. 11). The external table of the skull was pushed outward and it seemed that the pathological process had originated in the diploe and was ballooning the external and internal tables apart. The inner table was somewhat

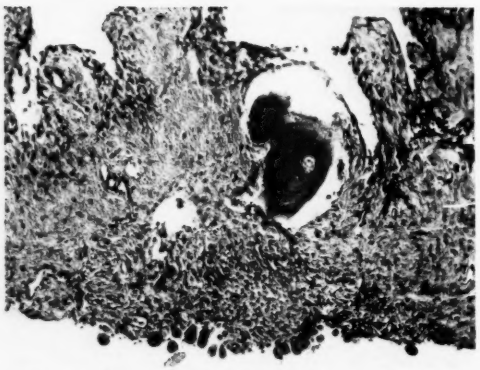

Fig. 12. Case 3. To demonstrate the general structure of the cyst wall. An adult bone lamella and giant cells resembling osteoclasts are seen. Hæmatoxylin-eosin stain; ×60.

depressed, but not markedly so, and its contour seemed smooth. All other portions of the skull wall conformed to the normal anatomical features. The face, jaw, and the upper cervical spine were likewise clear. There was no evidence of secondary manifestations of increased intracranial pressure. Roentgenological diagnosis was that of a bone cyst.

At the operation, under ether anæsthesia, a semilunar incision about the bony mass was made with the convexity of the incision toward the median line. The pericranium was separated and the skull exposed. The external table was of egg-shell thickness and had a transparent light color. Underneath the bony dome there was a thick membranous cyst containing yellow fluid. The external table was removed over the entire cyst, and the cyst wall was dissected from the bony floor. The latter consisted of multilocular cavities eroding the external and internal tables quite irregularly, but not breaking through the latter. The affected bone was burred and curetted until both tables appeared normal. The pericranium and galea were sutured. The dressing was applied with pressure into the cavity so that the pericranium and galea might become attached and begin to fill it in. The patient made an excellent postoperative recovery and was discharged 5 days after operation. X-ray examination of the skull made 2 months later showed some evidence of regenerated bone at the edges of the defect. All other shadows of the cranium, face, jaw, and upper cervical spine were normal.

Microscopic examination of the cyst wall removed at the operation revealed the presence of dense connective tissue, composed chiefly of spindle cells of uniform shape and size, without any definite lining membrane. The dense stroma contained smaller cyst cavities also without definite endothelial lining and empty. In one place a violet-red stained bony lamella, including bone cells was present. No osteoblasts were seen around it. Nearby but separated from it by an aggregation of round cells with heavy stained nuclei, there were about 8 to 10 giant cells (Fig. 12). Their cytoplasm was opaque and contained several small, oval, uniformly shaped nuclei, distinctly separated one from the other. Such giant cells also occurred in rare instances, scattered throughout the stroma but were chiefly found at the edges of the sections examined. No mitotic figures were seen. Here and there round cells and plasma cells were scattered loosely through the stroma, without any distinct perivascular infiltration. The tissue was not very vascular and hæmosiderin deposits were not encountered. The general appearance of the sections examined was that of a granulation tissue with evidence of bone formation and with presence of giant cells, closely resembling osteoclasts.

Diagnosis: Osteitis fibrosa cystica.

May 14, 1933, the patient returned stating that about 6 months before he noticed a tiny bony protuberance in the mid-parietal region, a little to the left of the midline. This had gradually grown until it was about the size of a bean. General physical and neurological examination was essentially negative. Urinalysis was found negative. Bence Jones protein reaction in the urine was absent. The blood Wassermann was negative; blood calcium, 9.57 milligrams per 100 cubic centimeters of blood serum; blood phosphorous, 3.66 milligrams per 100 cubic centimeters of blood; red blood cells, 4,300,000; white blood cells, 6,500 (polymorphonuclears, 62 per cent; lymphocytes, 35 per cent; eosinophils, 3 per cent); hæmoglobin, 90 per cent (T). The red cells were normal in shape, no poikilocytosis; no nucleated red cells; blood platelets were present. The coagulation time was 2 minutes 15 seconds. In the left frontal bone, just above the hair line, there was a depression in the external table of the skull about 8 centimeters in diameter, representing the site of the previous lesion and operation. The base of this depression was covered with good, freely movable skin, and felt bony in consistency. On X-ray examination of the skull (Fig. 13), there was in the frontal region just anterior to the frontoparietal suture and to the left of the midline, a depression of the inner table as well as of the external table; and in this depressed skull three good sized cyst-like areas, surrounded by ten or twelve smaller cyst-like areas. They seemed to be fairly well defined. These lesions looked like typical bone cysts. Posterior to the frontoparietal suture in the midline there was another area in which there seemed to be softening of the external table, over an area at least one centimeter in diameter. X-ray examination of the entire skeleton did not reveal anything pathological.

With the diagnosis of an osteitis fibrosa cystica, the patient was re-operated upon. In the area in which the external protuberance was felt in the parietal region a slate-blue appearing projection of the skull, about the size of a bean, covered with normally appearing pericranium, was found (Fig.

Fig. 13.

Fig. 13. Roentgenograms of skull of patient described in Case 3 in May 1933. Note depression of internal and external tables in the frontal region. Cyst-like areas of destruction are present in this area and the surrounding bone.

Fig. 13.

14A). After this bony dome was chiseled away and found to be very thinned external table of the skull, a cyst was disclosed, filled with bloody material. When the cyst was removed (Fig. 14B), the internal table formed the bottom of the cyst cavity and was found so excavated as to produce many very small loculi (Fig. 14C). In one of these there was a pulsation of blood, synchronous with the pulse, and one could see what appeared to be a pacchionian body in the dura mater. The cyst wall was removed completely. Small tags of pericranium were thrown into the cyst cavity and the scalp was sutured layer by layer. The wound from the previous operation was inspected and found filled with bone, so that while the skull at this point was depressed, there was a good, hard, firm bone in the place of the previous cavity. The patient made an uneventful postoperative recovery, being discharged 4 days after the operation.

Microscopical examination of the specimens removed, i.e., the cyst wall, bony dome of the cyst cavity, and particles of bone curetted from the cyst cavity, showed the following: The bony dome consisted of thinned but otherwise normally appearing bony lamellæ. Bone cells were present, and their lacunæ and the haversian canals seemed to be somewhat enlarged. There was no evidence of osteoblast or osteoclast activity. Several pieces of the cyst wall, removed piecemeal, consisted of very dense fibrous tissue with scarce giant cells. There were one or two places where hæmosiderin deposits were present. In some parts of the stroma groups of lymphocytes were present. Some of the portions of the cyst wall showed quite different pictures. Here the fibrous stroma was rather scarce separating smaller or larger groups of cells. It stained pinkish red by the Van Gieson method. The cells were elongated, round, or somewhat polyhedral with large centrally or excentrically situated nuclei, containing one or two distinct nucleoli and slightly granular cytoplasm. Many of these cells presented in their cytoplasm smaller or larger vacuoli. The cell borders were quite distinct and the cells were arranged, here and there, in clusters or in sheets. Where they were loosely lying in the stroma one could observe that their cell bodies were drawn out into filamentous processes connecting them with other cells of similar shape or with numerous also spindle shaped cells (Fig. 15). Mitotic figures were not seen. Some of these cells fused and seemed to start to produce giant cell formation. Very few of these were observed and mostly about blood vessels. In one particular portion of the examined sections the cells were surrounded by dark stained granules or spicules. The cells were not arranged specifically around the blood vessels which were rare in the sections examined and presented a well developed endothelial lining. Wide blood spaces lined by the above described cells and filled with blood elements were not seen. Scattered between those cells were many lymphocytes and plasma cells. The particles of bone curetted from the cyst cavity contained either red bone marrow or a very young connective tissue rich in capillaries.

Diagnosis: Osteitis fibrosa cystica.

Clinically the course of the disease in this case was that of a chronic, symptomless lesion

Fig. 14. Case 3. Sketch made at the time of operation showing A, Bony dome covering the cyst cavity; B, Dissection of the capsule; C, Multilocular base of the cyst cavity.

of the bone, typical of an osteitis fibrosa. As stated, involvement of more than one of the bones of the vault of the skull, in adjacent areas, has been observed. This was the case in our patient who presented two bone cysts, one just anterior to the frontoparietal suture and the other just posterior to it. Roentgenologically, the lesions presented some similarity to pictures observed in cases of hæmangioma of bone. In these cases, however, as pointed out lately by Bucy and Capp (81) the trabeculations visible on X-ray films arise in a common center and radiate out from the plane of the bone. The loculations in hæmangioma in comparison with giant cell tumor or bone cyst are somewhat smaller and the cortex of the bone is not expanded as in bone cyst but is partially eroded.

Histologically, the examination of the tissues removed at the operations revealed pictures characteristic of an osteitis fibrosa. As pointed out above, a transformation of the bone marrow into fibrous tissue, characterizing osteitis fibrosa, may be followed by regressive changes leading to bone cyst formation or by progressive changes, giving rise to a so called giant cell tumor. Cystic softening of the latter and spontaneous disappearance have several times been observed (82), so that it is not always easy to know exactly how the given bone cyst developed. This applies to our case.

Whereas the histological examination of the specimens obtained at the first operation showed, generally speaking, a picture of a granulation tissue with new bone formation and evidence of bone destruction—a picture typical of bone cysts occurring in the course of an osteitis fibrosa—the microscopical structure of the tissues removed at the second operation was quite different. The most striking feature at the second operation was the presence of large groups of the above described oval, round, or polyhedral cells with large mostly centrally located nuclei, containing one or two distinct nucleoli, slightly granular cytoplasm with distinct cell borders and drawn out filamentous cytoplasmic processes connecting most of the cells. Most of the cells contained vacuoli; presence or absence of mitochondria due to the paucity of material, could not be ascertained. Clusters and sheets of these cells were separated by a distinctly fibrillary stroma, stained red with Van Gieson's method. The general morphology and arrangement lead us to consider these cells as young osteoblasts, so called "osteoblast reserves" (Kolodny, 36), ready to build up new bone.

At first glance these cellular areas of the cyst wall removed at the second operation together with the elements of the hæmatopoietic series might suggest a malignant bone disease. When one takes under consideration the entire clinical and roentgenological picture of the patient together with the histological findings, such a possibility is rather easily excluded.

As already mentioned recurrences of osteitis fibrosa have been observed and reported (61, 69). The same is true of so called giant cell tumor. Kolodny (36) states that recurrences

seem to be unavoidable and are observed in about 20 per cent of all cases of giant cell tumors treated by a single curettage alone. According to him when a recurrence has taken place in a giant cell tumor the histology shows a variable picture and is always of an altered character.

The presence in the cellular areas as well as in the dense fibrous tissue portions of the cyst walls, removed at both operations, of multiple elements of the hæmatopoietic series, is not surprising in a lesion going on in the bone marrow or in close relation to it. In connection with this, it is well to remember that the so called giant cell tumors have been termed by Nélaton *tumeurs à myeloplaxes*, a term which has been changed to myeloid sarcoma and myeloma.

The true myeloma, i.e., a neoplasm arising from the elements of hæmatopoietic series, is a very rare condition with a rapid course. It affects patients between the ages of 40 and 60 and is characterized by the multiple areas of destruction of cortical bone, protrusion beneath the periosteum and finally infiltration of the surrounding structures. Pains in the affected bone, cachexia, and emaciation, secondary anæmia, enlargement of the spleen, hyperplasia of the regional lymph nodes, presence of the Bence Jones reaction in urine, alterations in the blood picture of the patient and metastases to internal organs, are usually present in cases of myeloma, whereas all these features were entirely absent in our case. The young man has had his lesion at least since 1919, the time of the accidental disclosure of his first bony prominence, and now enjoys perfect health.

A second possibility, due to the general aspect of the cellular areas in our case, is that of Ewing's sarcoma, which might undergo retrograde changes and thus produce a cyst formation. This type of bone tumor is also malignant, perforates the periosteum early, and metastases are observed early in the course of the disease. It is also characterized by the diffuseness of its involvement and the multiplicity of foci of origin in the same bone. Pains in the involved bone are an important and constant complaint, associated with febrile attacks throughout the course of the disease. The tumor cells are not infrequently arranged about blood vessels, no giant cells are seen and mitoses are abundant. Surgical exploration of these tumors usually leads to a continuous ulceration with a large fungus growth.

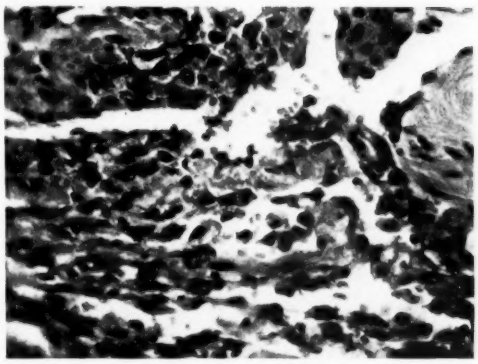

Fig. 15. Case 3. To demonstrate the general structure of the cellular area of the cyst wall. The cells are seen to lie partly in clusters, partly in sheets. The loosely lying cells are seen to be connected with each other by protoplasmic expansions. Van Gieson stain; ×400.

The absence of alveoli or tubules formations by the described cells as well as the lack of newly formed blood channels excludes the possibility of the presence in our case of a primary hæmangioma of bone (81) or angioendothelioma, described by Kolodny (36).

A direct proof that the bone cyst formations in this case were hæmorrhagic in origin is lacking. It has been shown conclusively that osteitis fibrosa, being a form of reaction of the bone to various noxious agents, may be found in the presence of a foreign body, infection, neoplasm, systemic disorders, circulatory disturbances (congestion), and hæmorrhage. A foreign body, infection, and neoplasm could be excluded in our case. Of the systemic disorders, parathyroidism has been shown to be the chief agent in producing an osteitis fibrosa (Mandl, 52). The absence of a visible or palpable enlargement of the parathyroid glands and a normal blood calcium rate in our patient allow us to exclude parathyroidism as an endocrine basis underlying the lesion. Osteofibrotic changes in the bone have been shown to be the result of congestion (50 a, b). Use of the bone acts then as irritant under

this condition. This, however, applies solely to the osteofibrotic changes observed in the long bones of the skeleton.

It can be reasonably assumed, therefore, that an intramedullary or intracortical hæmorrhage was the origin of the cystic formations in our case. This would be in accordance with the views upheld by the majority of observers as to the origin of benign bone cysts.

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ACUTE APPENDICITIS IN CHILDHOOD

With a Critical Analysis of 250 Cases[1]

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APPENDICITIS, wrote Lord Moynihan recently, is a subject concerning which wisdom has not yet descended upon all of us, and as one reads the astonishing teaching in the address that gave rise to his remarks, and what E. R. Flint terms the "even more lamentable" correspondence that it precipitated, one is inclined to question whether wisdom has yet descended upon very many of us. Sir James Berry, in "Fallen Idols," the address which he delivered last year as the one hundred-fifty-seventh annual oration before the Medical Society of London, literally turned the surgical clock back by pleading categorically and without qualification for a return of the days of delayed surgery in acute appendicitis, and the amount of damage he wrought was precisely in proportion to the greatness of his surgical reputation and the eminence of the organization before which he spoke. For weeks afterward the columns of the *Lancet* were filled with the controversy, the subject was debated at length before the Royal Society of Medicine and the Fellowship of Medicine, and the echoes still reverberate. The majority of surgeons who have participated in the discussion are perfectly willing to grant the advantages of delayed surgery in the late case of appendicitis, particularly the late case in which localization has occurred or is clearly occurring, though they refuse absolutely to accept it for the early case, particularly the early case of the obstructive type so well described by Wilkie. Not everyone, however, has so interpreted Berry's teaching, and the medical world has beheld the amazing spectacle of at least one distinguished surgeon pleading implicitly if not explicitly that the treatment of acute appendicitis be conservative until events, i.e., perforation, prove whether or not conservative treatment be practical.

Controversies of this sort are fortunately very rare today. The medical man who knows or suspects that he is dealing with acute appendicitis may occasionally be willing to take the chances of delay, but the surgeon who is willing to wait under such circumstances is becoming increasingly rare. The surgeon realizes that in such cases operation on reasonable suspicion shall be accounted to him for merit. He is willing to risk the performance of the occasional emergency operation that was not necessary and that might safely have been deferred. He is willing to risk the even more infrequent fatality that may follow unnecessary surgery. He is sustained by the conviction that the mortality and the morbidity that arise from such sources are minimal compared to the lives that are saved and the grave illness that is averted by immediate appendectomy in all reasonably suspicious cases. And he is correct: in appendicitis the basis of salvation is the realization that no man knows, no matter what his skill, what an hour, let alone a day, may bring forth, and the further realization, as Murphy wrote long ago, that distrust of the inflamed appendix is still the only safe surgical frame of mind. Bastianelli goes even further, and Bastianelli is a conservative surgeon: "When physicians are discussing," he says, "whether the case is appendicitis or not, it is. When they are inclined to admit the possibility of appendicitis without being perfectly sure of it, it not only is but it is about to perforate. When the diagnosis is sure, there is already perforation with a more or less circumscribed peritonitis."

If these things be true of appendicitis as a whole, they are even more true of appendicitis at the extremes of life. The average mortality for the acute disease is still, as it was in Murphy's day, about 10 per cent; it varies naturally, with the type of cases analyzed, as well as with other factors, but it is rarely, in collected series of any size, much under 1 per cent. Two-thirds of that mortality, however, occurs below the age of 12 years and

[1] From the Department of Surgery of the Louisiana State University Medical Center.

over the age of 40 years, although not more than one-third of all cases of appendicitis occur within those age groups, and it is universally granted that the disease in those periods of life differs in many respects from the disease as it is exhibited in the period of its greatest incidence.

Our interest in the subject of acute appendicitis in children was stimulated by a recent study which we made from the records of Charity Hospital in New Orleans of acute appendicitis at the upper extreme of life and in the course of which we were impressed again with the relative rarity and the absolute severity of the disease in infancy and childhood.[1] In the 1,294 cases of acute appendicitis treated in the hospital during the approximately 3 year period covered by our study of the disease in patients over 40 years of age, only 250 had occurred in children, but in this group, just as in the upper age group, we found the pathology in a very high percentage of cases to be of an extremely serious type, and we found the mortality, while it did not equal the mortality in the 100 cases just referred to, to be considerably higher than the mortality for appendicitis in youth and early adult life. It occurred to us, therefore, that it might be of value to analyze these 250 cases of the disease in children, just as we had analyzed the 100 cases of the disease late in life, and to endeavor to draw from them some conclusions as to why appendicitis which occurs in the lower age group should be so actually and potentially serious.

We might state at the outset that all of these 250 cases were really acute appendicitis, just as all of the 100 cases in the study just referred to were really acute appendicitis. We discarded all the cases in which the laboratory did not confirm the diagnosis unless there was unmistakable evidence that the laboratory and not the surgeon had erred. It had been our hope to compare the series we are reporting with other reported series, but it was a hope we were obliged to relinquish promptly, for the reason that exceedingly few of the other studies of the disease in children are confined to its acute manifestations. This situation, it seems to us, is greatly to be regretted; the inclusion of chronic and acute cases, of interval and emergency operations, in the same series, not only makes comparisons of similar types of pathology impossible, but also gives no fair picture of either group and simply confuses the discussion.

[1] Acute appendicitis over forty, with a critical review of 100 cases. Am. J. Surg., in press.

TABLE I.—DETAILED PATHOLOGY IN RELATION TO MORTALITY—250 CASES

Pathology	Cases	Mortality
Acute and acute suppurative	67	
Acute with general peritonitis	1	
Rupture	5	2
Rupture with gangrene	28	2
Rupture with gangrene and local peritonitis	14	
Rupture with gangrene and pelvic peritonitis	2	
Rupture with gangrene and general peritonitis	18	6
Rupture with abscess	15	2
Rupture with local peritonitis	3	
Rupture with general peritonitis	17	5
Gangrene	60	
Gangrene with local peritonitis	3	
Gangrene with pelvic peritonitis	2	1
Gangrene with general peritonitis	3	1
Abscess	12	

The outstanding consideration in acute appendicitis in children, just as it is the outstanding consideration in acute appendicitis in the upper extreme of life, is the very serious character of the pathological changes exhibited. In the series of 100 cases which we studied in adults over 40 years of age, we found that in only 23 per cent was the disease of the simple acute or the acute suppurative variety; in the 77 per cent remaining gangrene or rupture or abscess formation or peritonitis or a combination of these complications introduced factors which readily explain the mortality of 21 per cent. Table I, which represents the various types of pathology found in this series of 250 cases in children, shows very much the same picture. In only 27 per cent, a little over a quarter of the number, was the disease either of the simple variety or confined to the appendix, and the wonder is not that the death rate for the series proved to be 7.6 per cent, but that it was not found to be very much higher.

These figures, however, need further analysis. In the 67 cases in which the disease was of the simple acute or the acute suppurative variety, the mortality was 0; not a single patient operated on in that stage of illness lost his life. But the mortality for the remaining 183 cases, in which the pathological changes were more extreme, was 10.4 per cent. Furthermore, the mortality in those cases in

TABLE II.—PATHOLOGY AND MORTALITY OF APPENDICITIS IN THE NEGRO—51 CASES

Pathology	Cases	Mortality
Acute and acute suppurative	8	
Rupture	1	
Rupture with gangrene	10	
Rupture with gangrene and general peritonitis	8	3
Rupture with abscess	6	1
Rupture with local peritonitis	3	
Rupture with general peritonitis	3	
Gangrene	9	
Gangrene with general peritonitis	1	1
Abscess	2	

which peritonitis was not a complication was only 3.2 per cent, as compared with a mortality of 20.6 per cent, some six and one-half times higher, for the group of cases in which it was.

An analysis of the mortality from other standpoints is rather enlightening. As in most reported series, the male incidence is somewhat higher than the female, 148 against 102, but, unlike most reported series, the female mortality for some reason is higher than the male, that is, 8.8 per cent against 6.7 per cent.

Practically 80 per cent of these cases occurred in white children, although the admissions at Charity Hospital are rather evenly divided between the races, the proportion over a 10 year period running something like 45 colored to 55 white. Appendicitis in the negro, since he has taken on the fashions of civilization, is undoubtedly increasing, but the incidence, at that, is still considerably less than it is in the white race. On the other hand, when it does occur, it is apparently a disease of graver potentialities than it is among the whites, a point which has been made by Harbin, Miller, and other writers on this subject, and which an analysis of this series substantiates.

In the 51 cases in the negro, as will be seen in Table II, only 8 cases, 15.7 per cent, exhibited pathological changes of the uncomplicated variety, as compared with almost 27 per cent for the whole series, while the death rate was 9.8 per cent, as compared with a mortality of just over 7 per cent for the whites. The difference, as we say, is in our opinion due more to the inherent gravity of the disease than to external factors. It is true, as we shall point out later, that pernicious self-medication has a good deal to do with the serious manifestations of the disease

TABLE III.—PATHOLOGY AND MORTALITY OF APPENDICITIS UNDER 6 YEARS OF AGE—22 CASES

Pathology	Cases	Mortality
Acute and acute suppurative	5	
Acute with general peritonitis	1	
Rupture	1	
Rupture with gangrene	3	
Rupture with gangrene and pelvic peritonitis	1	
Rupture and general peritonitis	1	1
Rupture with gangrene and general peritonitis	5	3
Gangrene	2	
Gangrene with general peritonitis	1	1
Abscess	2	

in the negroes, but the lapse of time between the onset of symptoms and the application for treatment, while it ranged from 10 hours to 14 days, was, taken case for case, very little greater than in the whites.

It is necessary to study these figures also from the standpoint of age groups. In the 22 children from 2 through 5 years, the duration of illness ranged from 8 hours in one case to 7 days in another, only 4 in whom the duration of illness was stated being seen within the first 24 hours of their illness. This is not unexpected, for very young children cannot tell their stories intelligibly, if at all, and the analysis of their symptoms must be largely a matter of surmise. It is likewise not surprising that only 5 cases in the group, 22.7 per cent of the total number, were of the simple acute or acute suppurative variety, as compared with almost 27 per cent for the whole series, or that peritonitis should have been a feature in almost a third of the cases (Table III). The mortality for this age group is variously reported in the literature as from 15 to 40 per cent, and the death rate in this group in our own series, which represents about 9 per cent of the total number of cases, was 22.7 per cent. This compares with a mortality of 6.1 per cent for the group of children 6 years and over, who represent 91 per cent of the whole series of cases studied.

Another and a most important consideration is the relation of the duration of symptoms to the type of pathological change and to the mortality. We have already commented upon this point in discussing the disease in the negro and in very young children, but it is necessary to analyze it for the whole series of cases. Sixty-five patients, 26 per cent of the whole group, had medical attention within 4

TABLE IV.—PATHOLOGY AND MORTALITY IN RELATION TO DURATION OF SYMPTOMS—250 CASES

Pathology	12 Hours	24 Hours	2 Days	3 Days	4 Days	Over 4 days	Not stated
Acute and acute suppurative	17	18	14	7	2	6	3
Acute with general peritonitis				1			
Rupture			2		2	1	
Rupture with gangrene		5	12	3	3	2	3
Rupture with gangrene and local peritonitis		4	5	1	1	2	1
Rupture with gangrene and pelvic peritonitis			1		1		
Rupture with gangrene and general peritonitis	1	1	7	3	6		
Rupture with abscess	1	1	3	1	6	3	
Rupture with local peritonitis				1	1		1
Rupture with general peritonitis		2	3	1	3	8	
Gangrene	7	14	26	4	2	5	2
Gangrene with local peritonitis				1	1	1	
Gangrene with pelvic peritonitis							2
Gangrene with general peritonitis			2				1
Abscess			2	1	2	5	2
Deaths	1	1	8		5	3	1

to 24 hours of the onset of their symptoms, with a mortality of 2, 2.8 per cent. The mortality in the remaining 185 patients, whose symptoms had endured from 48 hours to 14 days, was 10.4 per cent, almost four times as high. Eight of the 77 patients operated on within 48 hours died, a mortality of 10.4 per cent, but 5 of the 30 operated on within 96 hours died, a mortality of 16.6 per cent. It is the old story in appendicitis, of the mortality increasing proportionately with each day of neglect.

Table IV shows the relation of the various types of pathological change to the duration of symptoms, and reveals about what would be expected, a degree of pathology increasing in more or less proportion to the delay in seeking treatment. Considerations of this sort can never be reduced accurately to statistics, for the reason that certain cases of appendicitis exhibit an exalted virulence from the onset, while in other instances pathological changes are occurring long before clinical evidences of them are apparent, but on the whole it may be fairly said that, other things being equal, the degree of pathological change is proportionate to the length of time symptoms are evident. The cases of general peritonitis and of abscess formation occurring within the first 12 hours may perhaps be doubted, on the grounds of inaccurate history and the practical impossibility of such extreme pathological changes coming to pass within so short a time, but that facile explanation cannot be used for the other groups, and there is evident in this table an astonishing number of instances of very serious degrees of pathological change occurring very early in the illness. More than half of the patients seen within the first 24 hours, for instance, exhibited types of appendicitis over and beyond simple inflammatory changes, as did more than three-quarters of the patients who were seen within 48 hours.

While these findings correspond in large measure with our findings in the 100 cases of acute appendicitis in adults, in whom less than half of the patients seen within 48 hours exhibited the simple type of disease, it is not the general rule in appendicitis, and it bears out the contention of all writers on the subject that appendicitis in children, as in old people, develops with a terrible rapidity when once it has gained a foothold; Gallie, for instance, states that something like 70 per cent of the children admitted to the Toronto Children's

Hospital enter with the appendix already ruptured.

It is unquestionably true, given the same duration of acute appendicitis in a child and in a young adult, that the former is likely to exhibit a much more serious and widespread disease than is the latter, but the explanations advanced are far from satisfactory. That rupture occurs early in children there is no doubt, and perhaps it occurs, as it is generally stated, because the structures of the appendix in childhood are very delicate and because they are made up of a relatively large amount of lymphoid tissue. But the acceptance of that hypothesis introduces further difficulties. It is universally admitted that tonsillitis is as frequent as it is in childhood because of the very large amount of lymphoid tissue in the tonsils at that time of life. But if the appendix also contains a very large amount of lymphoid tissue, and if the fundamental pathology of tonsillitis and appendicitis is the same—of that there can be little doubt—why should the former disease be so prevalent and the latter disease, at least relatively, so unusual? Is peritonitis so frequently present, and so frequently of the diffuse or spreading or general variety, whichever we may choose to call it, because of the short, "transparent" omentum of childhood and the weakened adhesive protection, or are there other causes? Finally, is the grave character of appendicitis in children, with its correspondingly high mortality, really due to a lower resistance in children, or to something inherent in the disease? We are far from sure that it is wise to accept without reservation loose statements about the low resistance of childhood. Children frequently exhibit an amazing amount of resistance to infection and to injury, and frequently recover from serious illness with a smoothness and promptness that make such an hypothesis untenable. We can offer no satisfactory replies to these questions, but we are unwilling to accept unqualifiedly the explanations that are generally advanced and accepted without question.

External factors contribute largely to the degree of pathological change found in acute appendicitis in children, not the least important being the very frequent difficulty of diagnosis. Peterson makes the statement that the differential diagnosis of the disease is really simpler in children than in adults because there are fewer conditions to eliminate, but that statement, like many others, breaks down when it comes to the test. There may be fewer conditions to eliminate, but their elimination is attended with very much greater difficulty. In the first place, the importance of an adequate history in the diagnosis of any disease is not a matter of debate; we are among those who believe, given the choice of history or examination upon which to make the diagnosis, that the history is infinitely more important. But we are dealing here with a group of patients who cannot tell their stories coherently if they can tell them at all, who must have their symptoms and the course of their disease related for them by parents and nurses who may have entirely overlooked the onset of the illness or who may misinterpret what they have seen. The powers of observation and of narration differ markedly in different individuals, even in the so called intelligent classes, and it is easy to conceive how wide are such differences in the persons treated at a public institution, particularly when they are of the negro race. Time and time again we have noted, in appendicitis as well as in other diseases, that the gravest illness has been discovered only after a lapse of time, or when coincidental circumstances directed attention to it. Furthermore, as Farr has pointed out, many children with appendicitis obscure their symptoms by their course of conduct. The average child, as he says, will play as long as it is possible for him to get about, until his pain becomes really disabling, and we found, in a large number of cases in this series, that that was quite true. The child felt sick, he had some pain, he vomited, then he felt better, and he went out to play, or was sent to school, sometimes for a few hours, sometimes for a day or two. A history of that sort is not unusual, and it is always misleading. Why should serious illness be suspected in a child who behaves in this fashion? Yet more than one death in this series is accompanied by just such a story.

The second point of difficulty is the frequently atypical character of the disease. Ap-

pendicitis at any age is not a disease of sharply classical outlines. In the series of 239 deaths analyzed by Miller, in 1930, not more than half conformed to the supposed classic triad of symptoms, while in the 100 cases of adult appendicitis which we personally studied the percentage of atypical histories was even higher. It was not by chance that Bruce, writing on the atypical symptoms of appendicitis, should have selected three of his four illustrations from childhood. We doubt the wisdom, indeed we indict the judgment of those surgeons, illustrious though they be—they include, among others, Lord Moynihan and the late John B. Murphy—who make categoric statements about the symptoms of appendicitis and especially about their chronology.

Moynihan, for instance, makes the unqualified statement that if pain be not the first symptom, appendicitis can be excluded. But can it? In 245 of these 250 cases, the histories were written in considerable detail, indeed were rather better than the average, but in only 224 cases was pain the first symptom, and there was no constancy as to where it developed. In the majority of cases, it is true, it finally localized in the right iliac fossa, but it sometimes did not, it sometimes began there, it sometimes began in the epigastrium or about the umbilicus, or in the pelvis, or even, in 5 cases, on the left side, in which location it remained until operation. Though in many instances it developed insidiously, it was usually of sudden onset, and in 22 cases, which is very characteristic, it wakened the child from sleep. The point to which we would direct attention, however, is not the variable character and location of the pain, but the fact that in 21 of the 245 cases about which we have complete data, it was preceded by other symptoms, by vomiting in 15, by fever in 5, and by headache in 1. That is a small percentage of the total number of cases, it is true, but it is large enough to invalidate, indeed, to make very dangerous, the statements of Moynihan and others that pain is without exception the first symptom of appendicitis. It usually is, but there are enough exceptions to the rule to make the generalization both worthless and misleading.

There is much else to cloud the diagnosis of appendicitis in children besides the fact that the symptoms do not always occur in the grouping or in the sequence in which one is taught to expect them. Seven of these 245 patients, 4 of them in the group in which vomiting was the first symptom, apparently had their illness precipitated by some dietary indiscretion, the error being occasionally very indiscreet indeed. The same number of patients, by the way, in our adult group dated their illness from dietary sins, and there is rarely a study of disease of the digestive tract in which a certain proportion of cases is not so ushered in. Dietary indiscretions in children are frequent enough to warrant very careful consideration and there is something to be said in defence of the physician who, however mistakenly, bases his therapy on the obvious facts and gives a purgative to rid the system of the offending food.

Constipation is ordinarily supposed to be a common symptom of acute appendicitis, but in only 25 cases in this series was it very marked. Seven patients exhibited a diarrhœa, of whom 1 died. In adults the association of diarrhœa with acute appendicitis has been, in our experience, a very serious sign, particularly in the disease as it is manifested in middle life and beyond. That it is less serious in children we are willing to grant, though we cannot, in the face of these histories, accept the statement of the occasional writer that it signifies a less severe type of illness. It always clouds the diagnosis, and it made particular difficulties in this series in 1 child who died. He was one of the patients under 5 years of age, and for the preceding 6 months he had had intermittent and severe attacks of diarrhœa. His fatal attack of acute appendicitis was ushered in in the same fashion, and it is small wonder that the diagnosis was delayed. The coincidence of intestinal infestation in 9 children, of whom 2 died, is probably only coincidence.

Ten of these children complained of dysuria, and in 14 cases, not all of them included in the 10 just mentioned, the urinalysis revealed blood cells, pus, or even casts. Such findings are not unusual in acute appendicitis in childhood, Tasche, Helmholz and Richter, among

others, mentioning them in their reports. The explanations are not entirely satisfactory. Our own opinion is that the abnormal findings are usually to be interpreted simply as manifestations of toxæmia. We consider less logical such explanations as direct involvement of the kidney, inflammation of the bladder by the juxtaposition of an appendiceal abscess, or the creation of a ureteritis from contact with the inflamed appendix. The etiology of the complication, however, we are not chiefly concerned with. We introduce it merely to emphasize another difficulty of diagnosis. It should be added that 2 of these children had had in the past clearcut attacks of pyelitis, for which they had undergone hospital treatment, and it was no simple matter to decide whether the present attack was another recurrence of the pyelitis or was really acute appendicitis.

Eight patients had chills, and in only 1 of this group was the disease of the simple acute type; peritonitis was a feature in 4 cases. Chills in the adult, particularly in the adult over 40 years, are in our experience of very great significance. Such patients almost invariably exhibit at operation a degree of vascular involvement that is always very serious, such as extensive gangrene, mesenteric thrombosis, even pylephlebitis, conditions that are frankly beyond the reach of surgery. The significance in children, however, in whom the vascular factor is not notable, is evidently much less, for none of the cases in this series in which chills occurred terminated fatally.

Pneumonia is the disease of childhood most likely to be confused with acute appendicitis, and Adams and Berger report a typical series of 145 cases of pneumonia in patients between 2 and 15 years, in 17.5 per cent of which the diagnosis was acute appendicitis. Trousseau's advice is sound, always to examine the chest of an infant who complains of abdominal pain, but the differentiation is not always so simple. Pneumonia and acute appendicitis in their classic forms are totally different diseases, and even in their atypical forms they are unlike in many particulars. The child with pneumonia usually has a higher temperature, a higher leucocytosis, a different type of breathing, a characteristic movement of the alae nasi, and an appearance of being much sicker than the child with acute appendicitis. But these differences are not always apparent. The temperature, the pulse, and the respiration of the patient with appendicitis may be, as we shall point out shortly, within any range. The respiration in childhood is always faster than in adult life, so an elevation must be very marked to be appreciated. The breathing in childhood is normally lower abdominal, and the child with acute appendicitis, in self-protection, often changes his normal type of respiration to the shallow upper abdominal type characteristic of pneumonia, both consciously and unconsciously holding his lower abdominal muscles rigid to protect himself against pain. In our opinion Holland's point of differentiation is, the X-ray excepted, as good as any, and is certainly practical: the child with pneumonia, like the child with any other infectious disease, will sleep for more or less long stretches, while the child suffering the pain of appendiceal disease will neither sleep himself nor let any one else sleep. It must not be forgotten, too, that pneumonia and acute appendicitis are not incompatible, may occur simultaneously. That was the situation in 2 cases in this series, in both of which the appendix had gone on to gangrenous changes before operation was done.

A discussion of pneumonia logically introduces a discussion of the relation between disease of the upper respiratory tract and acute appendicitis, the possibility of which has been acknowledged, as Gerstley points out, ever since Farssac of Bordeaux made the original observation in 1909. Tasche, Gerstley, Eliason, and others have emphasized the relationship, and Brennemann, who has made a special study of a certain type of abdominal pain, not appendicular in origin, which is associated with throat infections, has continued his study from the opposite point of view, feeling a quite natural degree of responsibility for his teaching, since it clearly introduces the possibility that some cases in which acute appendicitis is the chief pathology may be overlooked. His figures are worth quoting. He found in 35 hospital cases of acute appendicitis 17 per cent with throat infections, and he found in 10 consecutive private patients,

4 with gangrenous appendices, whom he saw in consultation, 9 with definite throat infections and 1 with a possible throat infection. In our 250 cases, 92 children, more than a third of the total, either had a history of repeated attacks of tonsillitis and upper respiratory infection, some immediately preceding the attack of appendicitis, or exhibited tonsils which were severely inflamed and cryptic and which must have been true foci of infection. The exact relationship between upper respiratory infections and acute appendicitis is not yet settled. It may be, as some writers assert, that the respiratory disease is responsible for indigestion and consequent intestinal fermentation, but it is more likely, in our opinion, that the same infection localizes in two separate and distinct places. Again, however, the etiology of the complication is not so important as the realization that the coincidence is possible. A child with an acute throat infection who develops abdominal symptoms needs very careful observation to rule out appendicitis. Some unnecessary operations have been done under these circumstances, but they are surely less to be regretted than the occasional disasters that have occurred because operation was not done.

The differential diagnosis, again, cannot be made, as Table V shows, on the basis of temperature, pulse, or leucocytosis. Acute appendicitis can exist with any degree of temperature from below normal to 105 degrees and above, although the more moderate elevations are more usual, and a hyperpyrexia usually means appendicitis plus complications. Acute appendicitis can exist, again, with a pulse rate below 80 as well as with one above 150. The pulse is rarely rapid at the onset of the disease, or even immediately after rupture has occurred, and much more important than the absolute rate are the changes which take place in it; a steady acceleration, even though slight, from hour to hour is very significant, but waiting for it, let us point out, brings about the very delay in treatment which we are seeking to prevent. Finally, acute appendicitis can exist with a leucopenia as well as with a hyperleucocytosis, with a differential count of 40 polymorphonuclear cells as well as with one of 98.

TABLE V.—PATHOLOGY AND MORTALITY IN RELATION TO TEMPERATURE, PULSE, AND LEUCOCYTOSIS—250 CASES

Temperature	Acute	Rupture	Gangrene	Rupture and gangrene	Abscess	Peritonitis	Deaths
to 98.6	8		4	1	1		
to 99	12		9	3	1	7	
to 100	28	1	27	4	8	13	4
to 101	12	1	9	6	10	18	5
to 102	6	1	8	8	1	15	4
to 103	1	2	1	5	6	6	4
over 103			2	1		4	2
Range—97.4° F. to 107° F.							
Pulse to 80	4	2	1				
to 100	35	1	25	3	7	10	1
to 110	7		11	4	1	12	1
to 120	10	1	15	10	10	15	2
to 130	7		5	6	2	9	4
to 140	3	2	1	3	6	8	4
to 150	1		1			4	4
over 150		1		1	1	5	3
Range—72 to 178							
Leucocytosis under 10,000	16	2	7	1	2	4	4
to 20,000	45	2	38	19	20	30	6
to 25,000	4	1	13	4	5	8	2
to 30,000	1		2	3	10	19	3
over 30,000	1			1	2	5	1
Range—5,000 to 43,700							

It is quite true that a leucopenia is usually of grave import—in this series 4 of the deaths occurred in children with a white count less than 10,000, but, on the other hand, 7 occurred in children with a white count over 25,000. Ochsner long ago contended that the chief value of the blood count in appendicitis was postoperative, and surgeons, while they still use it faithfully as a diagnostic measure, are more and more inclined to agree with him. The chief point to be noted about the temperature, the pulse rate, and the total and differential blood count is that any type of pathological change may exist within any range, and that they all are of differential value only in the aggregate, never independ-

ently for the individual patient for whom an individual diagnosis is being sought.

Enough has been said on these various points to make it clear that the diagnosis of acute appendicitis in children is no simple matter, and that the delay, the not always unreasonable delay, in the recognition of the disease explains at least part of the pathological condition which these patients exhibit. Another explanation is the type of treatment which is so very generally instituted and which inevitably leads, as Lord Moynihan well puts it, to therapeutic peritonitis and to a subsequent therapeutic death. It is the old, old story of abdominal pain and cathartics, and it crops up with ghastly regularity in every paper on the subject of acute appendicitis. In the adult series which we recently studied, 41 of the 100 patients stated that they had taken purgatives, but they practically all took them on their own initiative. In these 250 cases, 88 of the children, roughly one-third of the series, had been given purgatives, and we do not doubt, had the specific question been asked, that the number would have been materially increased, for in only a small percentage of the other histories was it stated categorically that a purgative had not been administered. In 11 cases the purgatives had been repeated, sometimes as many as 5 times, when the stomach, with what Moynihan calls "a most proper act of rebellion," had expelled the first dose. Now note the difference in the circumstances. The adult, with rare exceptions, takes his own purgative, acts on his own responsibility. The child, without exception, has the purgative forced upon him, usually by his mother or his nurse, occasionally, as in a few cases in this series, by the medical man, and he thus becomes the helpless victim of "the philocathartic propensities," to quote Lord Moynihan again, which seem to be inseparable from the state of motherhood.

We can do no better than to continue to quote Lord Moynihan on this theme, for no one else has written on it with the vigor and the force that he has. For more than 20 years, he says, he has not operated on a single case of perforated appendicitis in which the sequence of events has not been purgation and perforation. Into that alliterative sequence we would interpolate another word; we would make it read purgation, procrastination, and then perforation. For the chief danger of purgation is the procrastination which permits the intestines to be lashed into activity, which permits the appendix, as Deaver says, like Vesuvius, to balloon with pus and finally to burst its bounds while the instigators of the evil, the persons who have administered the purgative, wait to see what is going to happen. The physician, says Royster, when in doubt is given to leading laxatives, and that is true of the profession to some extent, but it is overwhelmingly true of the parents and guardians of little children who in their well meaning ignorance adopt the very method of treatment which is most calculated to produce disaster.

Moynihan is unquestionably correct when he says, all other considerations aside, that the mere giving of a laxative is indication enough for instant operation. Eighty-eight of these children had had purgatives, and 59 of them had ruptured appendices; the only reason rupture did not occur more frequently, we are sure, is because so many times the first dose or the repeated dose of castor oil was vomited. Eight of the 59 children with ruptured appendices died, which means that 40 per cent of the total mortality of 19 occurred in this group. It might be added that 25 of the 51 colored patients had taken purgatives, and that every negro death occurred in this group. The purgatives they took exceeded both in number and in violence, those in the white race, and the persistence with which they dosed themselves and the medicines they used would be almost humorous if the outcome of their method of treatment had not been so tragic.

Fifty-seven of these children, 22.8 per cent of the total number, had had previous attacks of appendicitis, but an attempted comparison with other series (Tasche and Spano, Freedman and others), in which the percentage is very much higher, is valueless, since the other series include, as we have already mentioned, the chronic cases also. The interesting thing in this group of patients, aside from the fact that the diagnosis was made so much more

simple by the previous history, was the type of pathological change, which was less severe than in any other group in the series. In 26 of the 57 cases, not quite half, the disease was simple acute or acute suppurative, as compared to the 67 cases in the whole series of 250, which is not quite 27 per cent. Peritonitis was a feature in only 9 cases, 15.8 per cent, as compared with an incidence of 35.2 per cent for the whole series. Finally, the death rate was just 3.5 per cent as compared with a mortality for the whole series of 7.6 per cent. Again we attempt no explanations. Individuals with repeated attacks may develop a degree of immunity to the disease, or recurrences may tend to happen in persons whose natural resistance is high. We merely point out that, whatever the reason, repeated attacks of appendicitis seem to confer upon the patient at least a relative degree of security.

In 6 cases in this series there was a specific history of trauma. The attack began immediately or very soon after some sort of abdominal injury, and the sequence of events was close enough, in point of time, to warrant an assumption of cause and effect. Children, we grant, are very frequently injured while playing, and the argument may be a specious one and the sequence pure coincidence, but that the relationship existed in these cases there can be no possible doubt, just as there can be no doubt of a similar relationship in the 6 instances reported by Speed in his series of 313 cases (Royster).

Another interesting and unusual group of cases has to do with the 4 instances of acute appendicitis associated with pelvic inflammatory disease apparently of tubal origin. Two of these patients were white, 2 colored, and the ages were respectively 4, 5, 9, and 10 years. One child had a positive gonococcal smear, in the other cases no bacteriological examination of the vaginal secretions seems to have been made. In each case the appendix was definitely diseased, in each case there was equally definite evidence of tubal involvement, and speculations as to the primary cause of the pathology offer an interesting field. Pelvic inflammatory disease is most unusual in young children, indeed is denied altogether by some gynecologists, yet the case with the positive smear, if no other, would seem to be a case of ascending infection. Are the 3 other cases of the same type? Or are all of them instances of tubal disease secondary to acute appendicitis, the positive vaginal smear being merely a coincidence? Again we do not attempt to answer our own questions, we merely state them as problems which are open to discussion.

TABLE VI.—OPERATIVE PROCEDURE AND TYPE OF INCISION IN RELATION TO MORTALITY —250 CASES

Procedure	Cases	Deaths
Appendectomy	130	3
Appendectomy with drainage	36	3
Appendectomy with drainage and enterostomy	65	9
Drainage only	16	2
Colpotomy	1	1
Enterostomy and drainage	2	1
Incision		
McBurney*	126	3
Right rectus	86	10
Battle	24	3
Midline	2	1
Colpotomy	1	1
Over mass	7	1
Not stated	4	

*3 converted into Weir.

A word might well be said as to methods of examination in children, for abdominal examination is no simple matter. It is the part of common sense to avoid at first the point of supposed tenderness, to approach the region of greatest pain only after some degree of confidence has been established. It is likewise an excellent plan to examine the child during sleep, though it is rarely possible of achievement. Of all the advice which has been given, Christopher's strikes us as the soundest, that a "too boisterous Polly-anna-ism" is heartily to be condemned; a child in the agonies of acute appendicitis has enough to bear without being further insulted by the vagaries of an adult endeavoring in this fashion to establish a rapport with him.

As to the interpretation of the abdominal findings, it must be remembered that rigidity in children is frequently absent, indeed almost always is absent if the appendix is retrocæcal or lies deep in the pelvis or if examination is done before a peritoneal reaction is established, just as it must be remembered that the complaint of tenderness is likely to be misleading because the child, in his fear of being hurt, will complain at the slightest touch. Examination by rectum is not always easy, but it is

in our opinion a very valuable diagnostic aid, far more so than it is in the adult because the examining finger can reach higher and feel more. It was carried out in 53 cases in this series, with positive findings in 50; bilateral pain, indicating diffuse pelvic inflammation, was present in 14 cases. The procedure was equally valuable in examining a number of patients after operation, in order to confirm or eliminate the presence of residual abscess.

Table VI, which sets forth the procedure in relation to the mortality, needs little comment. The figures speak for themselves. Whether the 3 patients who died after simple appendectomy would have lived if another plan had been followed is beside the point; no one can decide that now. The thing to note is that in this series, just as in most reported series (Farr, Hudson, Woodall, and others), in very nearly half of the cases, drainage, either alone or in combination with enterostomy, was considered necessary because of the type of disease which had to be dealt with. That the great majority of deaths occurred in this group of cases has, in our opinion, and as we have repeatedly said in previous papers on appendicitis, nothing whatsoever to do with the wisdom or unwisdom of the procedure. The whole acrid controversy over drainage versus simple closure is futile. The wisdom of drainage, after the event, can be judged on just one point, the degree of pathological change to be combated, and of its seriousness in this group of cases there can be no possible doubt. It is very easy, as Royster says, to play the game after it is finished, and into that fallacy we decline to be led.

Cæcostomy as an auxiliary procedure was done in 65 cases, something over a quarter of the total series, something over half of the number of cases in which the conditions present demanded a more radical procedure than simple appendectomy. That is a very high proportion, and the wisdom of the procedure is, as we have said in previous papers on acute appendicitis, at least open to question. It is apparently routine under certain circumstances among the group of surgeons who performed the bulk of these operations, and certainly there is much to be said in its favor. It is far more effective as a preliminary procedure than late enterostomy. It shortens the actual operating time because it eliminates closure of the bowel. It reduces postoperative distention and permits adequate intestinal drainage, and it therefore acts as a prophylactic against the development of ileus. In children as in adults, fistulæ in this region tend to close spontaneously; in only 3 cases in this series did the patients leave the hospital with a discharging sinus. Moreover, a criticism of the death rate in the cases in which it was done, 9 of 65, 14 per cent, is not fair for exactly the same reason that a criticism of the percentage of cases drained is not fair; only a surgeon present at all the operations could properly decide when enterostomy was justified and when it was not. On the other hand, granting all of these things, we still wonder whether it should have been performed as frequently as it was. For one thing, it prolonged the convalescence in many cases quite out of proportion to the apparent clinical course: 30, 40, 50, and 75 days' stay were not uncommon, and one patient was in the hospital 94 days. More than 40 per cent of these 250 patients, 104, were in the hospital longer than 2 weeks, and at least part of their prolonged stay must be set down at the door of surgery that was perhaps more zealous than was actually necessary.

The 18 cases in which drainage only was done (in 2 cases combined with enterostomy) undoubtedly represent a wise conservatism. The removal of the appendix, other things being equal, is greatly to be desired, but is never to be recommended unless it can be done swiftly, without undue prolongation of the operative procedure and anæsthesia, without the soiling of uncontaminated areas of peritoneum, and with a minimum of trauma. It must not be forgotten that very many of these little patients were exceedingly ill and in no condition to withstand a single extra moment of anæsthesia or a single extra operative manipulation. We were repeatedly struck, as we read these charts, by the emphasis which even careless and unperceptive internes placed upon the appearance of the children, the acutely ill impression they created, the anxious, hippocratic facies that gave

eloquent evidence of the intraperitoneal damage that had been wrought.

The single case in which only colpotomy was done and which terminated fatally should be particularly commented upon, though we by no means would imply that another procedure might have changed the outcome. Colpotomy is valuable as a postoperative measure for a cul-de-sac abscess, but we are very doubtful indeed as to its propriety as a primary procedure, without an abdominal incision to determine exactly what conditions are present within the peritoneal cavity.

The type of incision employed in acute appendicitis depends very largely upon the personal preference of the surgeon who is doing the operation. There is something to be said for each, though the end-result, in our opinion, depends far less upon how the abdomen was opened than upon what type of pathological change had occurred within it and what degree of suppuration occurred after it was closed. The McBurney incision, if all goes well, permits the conduct of the whole operation within a small area shut off from the general peritoneal cavity, it reduces peritoneal soiling to an inescapable minimum, it reduces the risk of postoperative hernia, and it usually permits satisfactory drainage. But all does not always go well. The most careful anatomist, the most expert surgeon, whose McBurney incision is truly a McBurney incision —many crimes, of course, have been committed in McBurney's name—often encounters his own troubles in getting out through such an opening an appendix that lies out of its normal location; Treves was perfectly correct and very wise when he pointed out years ago that the one thing constant about the position of the appendix is its inconstancy. In 3 cases in this series—by chance they happened to be consecutive cases—the appendix lay entirely out of reach through the McBurney incision, which had to be converted into another type. Incision over the mass, of course, is sufficient if a mass is demonstrable, and represents a very sound conservatism.

An analysis of the wound infections in this series (Table VII) shows several interesting things, the first of which is that the incidence of this complication seems to have very little to do with the type of incision. It is true that nearly 25 per cent of the patients with right rectus incisions developed wound infections, against only 19 per cent with McBurney incisions, but a higher percentage of the former group were drained, and it is our opinion that the incidence of this complication depends more upon the extent of the original pathology than upon any other single factor. None of the patients who died developed wound infections, probably because most of them made their exit so promptly.

TABLE VII.—WOUND INFECTIONS IN RELATION TO PATHOLOGY, PROCEDURE, AND INCISION —52 CASES

Pathology	Cases
Acute	3
Rupture with gangrene	7
Rupture with gangrene and local peritonitis	5
Rupture with gangrene and pelvic peritonitis	1
Rupture with gangrene and general peritonitis	8
Rupture with local peritonitis	1
Rupture with general peritonitis	5
Gangrene	12
Gangrene with local peritonitis	2
Gangrene with pelvic peritonitis	1
Gangrene with general peritonitis	3
Abscess	4
Incision	
McBurney	24
Right rectus	21
Battle	5
Over mass	2
Procedure	
Appendectomy	23
Appendectomy with drainage	17
Appendectomy with drainage and cecostomy	10
Drainage only	2

In addition to this complication, and excluding the patients who died, the following postoperative complications are represented in this series: fæcal fistulæ (3); hæmatoma of the wound; mild upper respiratory infections (4); bronchopneumonia (4, in addition to the 2 pre-operative cases); sinus arhythmia brachycardia; œdema of the scrotum; rectal hæmorrhage; pyelitis (2); furunculosis; bed sores. One intestinal obstruction was handled successfully by ileostomy, 1 cul-de-sac abscess was drained by colpotomy, and there was 1 case of evisceration with repair. Thirty-seven patients had a very rugged course, and in all of them the liberal use of fluids by all routes for many days after operation undoubtedly had much to do with the favorable outcome. Transfusion was done in 4 cases with good results. Many of these children were either in a state of acidosis, or on the verge of it, when they were operated on, and its control was of great importance, for children do not tolerate

starvation well, whatever its cause may be. One child had a severe case of rheumatic heart disease and was fortunate to escape with his life, for 2 others, similarly afflicted, succumbed.

In all but 6 cases operation was done promptly on admission, and in 2 of these death occurred. In one instance the condition was considered, incorrectly as it proved, to be a subsiding subacute appendicitis, a diagnosis which was warranted from both the history and the findings on admission, but operation disclosed a gangrenous appendix with general peritonitis, a state of affairs entirely inconsistent with the clinical symptoms. The other fatality belongs in the group described by J. B. Hunter as the "unsuccessfully delayed" case, the type of patient who is in worse condition to withstand surgery because of delay than if he had been operated on promptly. Undoubtedly immediate operation is the wiser plan in children, just as it is the wiser plan at any age. Hope deferred, as Royster well says, often maketh the patient sicker, and that is particularly true of little children, who do not tolerate the expectant plan of treatment, and in whom, even more than in adults, it is impossible to tell what a single hour may bring to pass. It became more and more our conviction, as we studied these cases, that the great majority of the patients who lived owe their lives to the promptness with which surgery was instituted. Indeed, we have only commendation for most of the surgeons who handled the cases we threw out because the laboratory did not confirm the clinical diagnosis. The occasional unnecessary operation on a wrong diagnosis, as we have already pointed out, is infinitely better than a delayed operation on a correct diagnosis, which terminates, as it frequently does, in a life lost. In other words, under the proper safeguards, the look and see policy is far safer than the wait and see policy. In acute appendicitis the suspicion that one is dealing with acute disease will save many a patient who would be lost if the removal of all chronic and subacute appendices whose exact pathology were not certain should be deferred until the interval.

The causes of the 19 deaths, 10 of which were verified by postmortem examination, include: rheumatic heart disease (2); pneumonia; pulmonary œdema; anæsthetic (ether, on the table); peritonitis and its complications (1); toxæmia (2, in 1 case with evisceration). Eleven of the patients died within 24 hours, 2 of them within 6 hours, and while the mortality must be figured on the basis of the total number who died against the total number who lived, it is not unfair at least to point out that a certain percentage of the children who died were beyond the reach of medical aid when they entered the hospital, indeed were actually moribund, and that surgery was resorted to not with the hope or expectation that their lives could be saved but simply as the surgeon's instinctive attempt at rescue, his instinctive gesture of succor.

SUMMARY

That this study of 250 cases of acute appendicitis in young children contributes anything new to the subject we are not fatuous enough to believe. That it emphasizes again certain considerations which can profitably be emphasized again we do sincerely hope. We have endeavored to make three chief points: that the pathological process in children under 12 years of age is far more serious than it is in youth and early adult life, even though the incidence is considerably lower; that the gravity of the disease is dependent not only upon the inherent virulence of the infection but also upon the delay attendant upon the difficulties of diagnosis and upon the very frequent administration of drastic and lethal purgatives; finally, that the outcome in any given case, or any given group of cases, depends not so much upon the exact procedure adopted as upon the promptness with which it is adopted and the wisdom which correlates the pathological process present with the extent of surgery done. If we have brought to mind again these essential considerations in acute appendicitis in children, we shall have fulfilled our own aims and shall have contributed, we trust, something of value in the study of this treacherous and highly fatal disease.

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THE VENOUS PLEXUS OF THE ŒSOPHAGUS

Its Clinical Significance[1]

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MEDICAL literature contains an abundance of information concerning varices of the œsophagus in connection with obstruction of the portal and hepatic venous pathway; anatomical studies have been reported and these reports have been quoted by others (6, 8, 9). However, the normal venous plexus of the œsophagus, and the nature of the connection between the portal and caval circulations, has received little consideration. Because of lack of this rather important fundamental knowledge the following study was undertaken.

Of the many specimens of which injection was made in this investigation, it was possible to carry out the technique in 16, with sufficient accuracy for good results. Of this number, 8 specimens were considered satisfactory for a detailed study.

METHOD

Injections may be made into the venous plexus of the œsophagus through the coronary vein of the stomach on the portal side of the circulation, or through the azygos major vein. The coronary vein of the stomach being the most direct route, gave the best results. Figure 1 shows the coronary vein of the stomach and its connection with the œsophageal veins and other venous channels in that region.

RESULTS OF INJECTIONS

The periœsophageal plexus described by other workers was not demonstrated, but in its place were found three or four longitudinal trunks with little or no cross anastomosis.

The submucosa of the œsophagus was found to be richly supplied with veins situated both above and below the muscularis interna, the former lying close to the mucosa or protective layer. All of these channels were closely connected by many communicating or perforating branches. Only in so far as the region above the cardia is concerned, the submucous plexus was noted to be very poorly supported by loose connective tissue, thus not entirely confirming the findings of other investigators. In these preparations the veins at the cardia were found to be strongly supported due to the increased thickness of the muscularis interna. The mucosa was also more adherent in this region and was bound together by interlacing, elastic fibers and connective tissue. The plexus of veins in the submucosa was found to be extremely variable, although conforming to a general type of distribution. Clinically and pathologically this plexus appears to be of the greatest importance.

In the 8 cases studied, the presence of a fine capillary anastomosis between the caval and portal circulation at the extreme lower end of the œsophagus was established. These fine venules were found to run longitudinally in the long axis of the œsophagus, beginning at the mucocutaneous juncture, or line of termination of the columnar epithelium of the cardiac end of the stomach and extending upward for a distance of 4 to 5 centimeters, with absence of any cross anastomoses. This region corresponds to the so called anatomical cardia of the œsophagus. In 3 of the cases studied, in addition to the small venules already mentioned, several larger veins, 3 in each case, were seen to cross the cardia.

Below the cardia the coronary vein of the stomach, after giving off a few periœsophageal branches, pierced the serosa and muscularis obliquely for several centimeters, giving off two to four main branches or trunks in the submucosa. These gradually broke up into small, anastomosing branches which just before the cardia was reached became broken up into numerous fine longitudinal capillary-like structures to continue across the cardia as already mentioned (Figs. 2 and 3).

Above the region of the cardia the veins of the submucosa were free, due to the loose connective tissue framework which poorly

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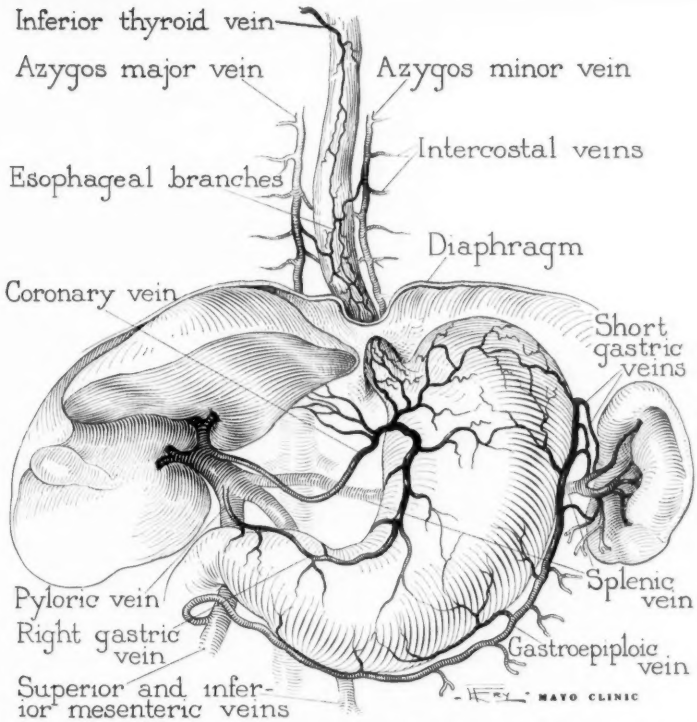

Fig. 1. Coronary vein of the stomach and its connection with the œsophageal veins.

supported them. The veins in this situation were larger, and an abundant capillary network united the three or four main longitudinal trunks by cross anastomoses. The anastomotic radicles formed a dense network in the lower œsophagus but at the level of the bifurcation of the trachea the plexus became less complex (Fig. 4). Below the latter point, all sides of the œsophagus usually were well supplied with veins, with no given preference for any certain region.

Large, saccular dilatations were seen along the course of the larger venous trunks in the submucosa of the œsophagus above the cardia. They were not artefacts, since the injected mass did not diffuse into the surrounding tissues. Serial sections were made of one of these saccular structures and it was found to be a hemangioma, probably of congenital origin.

CONSIDERATION OF RESULTS AND SURGICAL ASPECTS

Failure to obtain satisfactory injection of the venous plexus of the œsophagus cannot be entirely ascribed to the inherent lack of anastomotic channels between the portal and caval circulations at the cardia, although such a condition must be recognized. It is possible that minute blood clots obstructed the finer venous radicles preventing the entrance of the injected mass, even though measures were used in an attempt to prevent such an occurrence.

The connection between the splenic and œsophageal veins is worthy of consideration. It seems possible that varices of the œsophagus may form independent of cirrhosis of the liver in diseases of the spleen, especially splenic anæmia and Banti's disease. Diminution in the size and number of the splenic

sinuses obviously interferes with the outflow of the splenic blood, and collateral channels must then necessarily be established. In this investigation an extensive connection was found to exist between the lower end of the œsophagus and the spleen, through the veins that accompany the vasa brevia and the coronary veins. Failure to block off this connection produced poorly injected specimens.

The results of injection of the veins of the œsophagus seemed in general to answer the description given by Poirier and Charpey. I was impressed by the minute size of the veins at the cardia. It is probable that this capillary-like anastomosis at the cardia offers marked resistance to the flow of blood from the portal to the systemic veins, as is the case when the portal circulation becomes obstructed. In such instances the increase of venous pressure must exert itself on the veins below the cardia for some time before the resistance at the cardia is overcome. Varices result from an increased flow of blood through a vein, and from inability of the muscular and elastic fibers to withstand increased intravenous pressure. At the cardia, as has been noted previously, the submucous veins of the œsophagus are well supported and it is reasonable to believe that the formation of varices first occurs below the cardia and secondly above that point after collateral channels of anastomosis have been established. Where several veins of large caliber cross the cardia, as has been noted in some of the cases, the formation of varices above the cardia is probably more rapid. When present, they are no doubt the first veins in the region of the cardia to become enlarged.

Ligation of the left coronary vein of the stomach in a case of hepatic cirrhosis associated with bleeding œsophageal varices was first reported in 1929 by Walters, Rowntree, and McIndoe. Absence of melæna following operation was noted. A further report was made by Rowntree, Walters, and McIndoe later in the same year. Here the bleeding œsophageal varices were found in connection with Banti's disease; the spleen and liver were both found to be enlarged. At the time of operation, April 18, 1929, it was felt that the procedure was questionable because dilatation of the coronary veins was not extreme. Splenectomy was considered at the time of operation, but inasmuch as the new procedure meant less surgical risk, the vein was ligated. The patient made an uneventful recovery and returned home, but May 31, 1929, a severe hæmorrhage occurred and he was almost exsanguinated. The spleen was removed July 17, 1929, and recovery was uneventful. Since then, ligation of the left coronary vein of the stomach for bleeding œsophageal varices has been carried out in 5 cases, with uneventful convalescence. The ultimate results, however, cannot be stated at this time.

As a result of my study it seems doubtful that ligation of the left coronary vein of the stomach would have any beneficial effect on bleeding œsophageal varices secondary to splenic anæmia and Banti's disease. The extensive connection which exists between the veins that accompany the vasa brevia of the spleen and the veins of the œsophagus precludes such a possibility. On the other hand, in hepatic cirrhosis associated with bleeding œsophageal varices, ligation of the left coronary vein of the stomach is indicated since it interrupts the main flow of blood from the portal vein to the œsophagus.

It appears reasonable that ligation of the veins that accompany the vasa brevia might be beneficial in cases of bleeding œsophageal varices associated with splenic anæmia and Banti's disease, especially in cases in which splenectomy would be considered a grave operative risk. The technique of ligating these veins would obviously be difficult, due to their poor accessibility, and this might be a contra-indication to such an operation. These procedures, as has been mentioned, although still in an experimental stage, offer new possibilities in the treatment of such conditions. Sectioning of these veins in the course of splenectomy may explain the relief from serious hæmorrhage which is often afforded by this procedure.

Walters has reported a considerable surgical experience with these cases (12) and recently (13) has suggested that an additional method of reducing the amount of venous blood in the œsophageal varices might be injection of the periœsophageal or paraœsophageal plexus

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 2. Injected lower part of œsophagus showing branching of coronary vein below the cardia.
Fig. 3. Lower two-thirds of injected œsophagus.
Fig. 4. Lower four-fifths of injected œsophagus. This is the same specimen as that shown in Figure 2 but fewer details are evident. The figure is introduced here to show the disappearance of the veins as higher portions of the œsophagus are examined.

of veins with some non-irritating, yet sclerosing, solution, a method similar to that employed for obliterating varicose veins of the leg. The solution should be injected through a very small needle so as to prevent undue bleeding from the needle puncture in the vein. Should bleeding occur, ligation of the vein at the site of the needle puncture could be carried out.

COMMENTS

Hæmorrhage from the submucous venous plexus of the œsophagus is always of serious moment. Clinically it is usually associated with varices of the œsophagus, but it is apparently possible to have bleeding occur from the normal veins, which occasionally assume sinus-like dimensions. The anatomical situation of these veins makes them susceptible to ulceration, rupture, and hæmorrhage. The combination of a number of factors is probably responsible for hæmorrhage from these veins.

Inflammation of the œsophagus is no doubt an important prerequisite for hæmorrhage. At the Mayo Clinic, one case has been seen in which, at necropsy a marked pseudomembranous œsophagitis was found. The epithelium was denuded and replaced by an exudate composed of polymorphonuclear leucocytes, fibrin, and erythrocytes. Large, dilated venules in the submucosa were seen to be exposed by the ulcerative process (Fig. 5). The patient was a man, aged 72 years, who died of carcinoma of the head of the pancreas and bronchopneumonia. Blood was found in the stomach and intestines, although a bleeding point could not be found in either situation. It is probable that hæmorrhage occurred from the œsophagus and was a factor in causing the patient's death.

Trauma may play a part in causing rupture of the veins. It is doubtful if the passage of an ordinary stomach tube is injurious in these cases, according to Bartels. However, a tube of the Rehfuss type which has a metal olive tip may produce enough trauma to cause hæmorrhage.

With impairment of the blood supply, either through failure of arterial blood to reach the

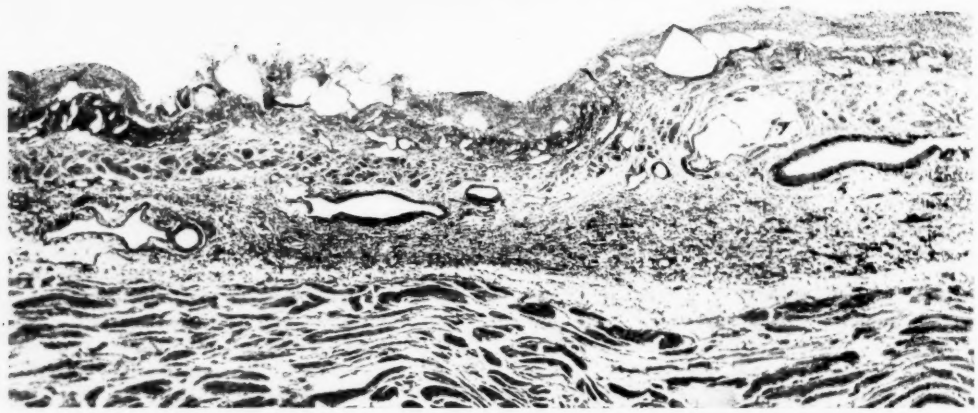

Fig. 5. Pseudomembranous œsophagitis showing exposed veins on surface (×22).

œsophagus, or through venous congestion or stagnation, the avascular epithelium is soon deprived of nourishment, thus falling prey to infection and also to regurgitated gastric content containing acid and digestive enzymes.

It is in such instances that varicosities, such as those associated with cirrhosis of the liver, produce nutritional disturbances of the mucosa, œdema, and congestion of the submucosa, with consequent degenerative changes, infection, ulceration, and rupture of the œsophageal veins.

Regurgitation into the œsophagus of gastric content containing dilute hydrochloric acid and pepsin, is not an uncommon occurrence. The incompetence of the cardia has been recognized by Alvarez, Jackson, Joannides, and others. Robins and Jankelson observed true cardio-œsophageal relaxation with regurgitation of barium into the lower part of the œsophagus in 103 cases, or 4.6 per cent of those patients examined roentgenographically and fluoroscopically. They expressed the belief that cardio-œsophageal relaxation is not a clinical entity, and that it can be demonstrated not only in diseased, but also in normal persons.

In order to determine the relative frequency of œsophageal regurgitation, Kirklin and his associates at the Mayo Clinic observed 150 consecutive cases in which a complete gastrointestinal roentgenological study was made. Each patient was examined in the recumbent and in the Trendelenburg position. Of the patients examined, 15 (10 per cent) had very slight regurgitation of barium into the œsophagus, but not filling more than 2 inches of the distal third. In 2 cases there was marked regurgitation. Nausea was not experienced by any of these persons. If this is the finding among ambulatory patients, the frequency of regurgitation is probably high among those acutely ill.

Prolonged retention of acid and pepsin undoubtedly exerts a deleterious influence on a diseased or injured mucosa. This was demonstrated by Friedenwald, Feldman, and Zinn in their experiments on dogs. Prolonged vomiting, especially the postoperative type, is probably most harmful to the œsophageal mucosa, especially in association with a deficient circulation, and the probability of hæmorrhage from the venous plexus must be considered.

CONCLUSIONS

1. The submucous venous plexus of the œsophagus has been demonstrated by injection through the coronary vein of the stomach in 8 of 16 cases, or 50 per cent.

2. The presence of a periœsophageal plexus of veins was not demonstrated, but rather a system of large venous trunks with absence of cross anastomoses.

3. Conclusive evidence of a channel of anastomosis between the portal and caval circulation at the cardio-œsophageal juncture in the absence of portal obstruction has been demonstrated.

4. Results of other workers concerning a connection between the spleen and the œsophageal veins through the veins that accompany the vasa brevia have been confirmed.

5. From this work, one may conclude that the venous plexus of the œsophagus is a vulnerable structure and hæmorrhage may occur in conditions other than portal hypertension; such as cardiac decompensation, diseases of the spleen, and trauma or ulceration of the œsophagus.

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THE DIAGNOSTIC VALUE OF THE DOUBLE CONTRAST ENEMA

With Special Reference to the Diagnosis of Early Neoplastic Lesions of the Colon[1]

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THE diagnostic value of the X-ray is so dependent upon the contrast of shadows cast by the various ray traversed tissues that the roentgenologist is constantly on the alert to intensify these contrasts. That was the purpose of Fischer's (2) barium air enema; better to distinguish the colonic lumen lesions which in their incipiency are all too frequently obscured in the simple barium study.

The use of air as an aid in roentgenology is by no means recent, having been employed in the study of the stomach and colon long before the insoluble salts of the heavy metals. As a medium for contrast visualization in colonic pathology it has not become popular, because, alone, it generally fails to produce a demarcation from the neighboring, partially air-filled intestinal segments great enough to render the colonic outline distinctly visible. Air has frequently been injected into the colon in order to outline intra-abdominal tumors and the lower border of the liver and spleen, as well as into the bladder in order more clearly to demonstrate intravesicle growths, while the success of ventriculography and encephalography is dependent upon its presence.

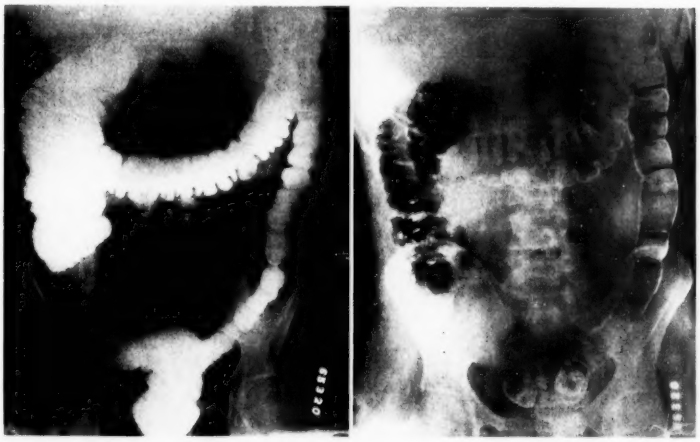
The introduction of the insoluble salts of the heavy metals as an aid in the study of the gastro-intestinal tract has rapidly supplanted any use air as a contrast medium may have enjoyed. Unfortunately, a satisfactory examination can not always be achieved with a barium or bismuth enema examination.

The difficulties encountered by the radiographer are due usually to his inability to fill the colon completely with the opaque mixture or to the inaccessibility to proper palpation of the splenic flexure, cæcum, and sigmoid. Satisfactory visualization and separation of redundant portions, particularly in the presence of adhesions, are frequently unattainable. Confronted with these difficulties, Stewart also felt the need for additional studies, and has devised a clever technique that operates in the sigmoid. The demonstration of *early* pathological mucosal processes, like polyps adenomata, ulcers, and carcinomata, by means of the single contrast enema is too often impossible. Fischer recognized this inadequacy and returned to the use of air, but in combination with the opaque salts; the double contrast method. This causes the colonic walls to be covered with a thin coat of barium which, in its turn, is layered with a column of air. The result is an easy visualization of the entire colon, no matter how redundant. Intraluminal growths, too, are sharply outlined, as are even minimal lesions of the mucosa.

TECHNIQUE OF THE DOUBLE CONTRAST ENEMA

A barium enema is given the patient by the usual technique. We use 8 ounces of barium sulphate to 2000 cubic centimeters of water, our only precaution being to mix the two thoroughly. After the usual fluoroscopic and roentgenographic examinations, the patient is allowed to evacuate the colon and return for fluoroscopic study. Careful examination is made of the residual contents in the terminal ileum and colon and this is generally followed by radiographic record. Then the colon is inflated with air, pumped by hand pressure through a short length of rubber tubing about two feet long, a small Politzer bag with ball valve in the bulb being used. No special rectal catheters are used, the ordinary hard rubber nozzle having been found satisfactory in all ordinary cases. If we are confronted with an incompetent sphincter an olive tipped catheter is used. We have found it unnecessary to use a stop cock device, as described by Weber and Fischer, because the ball valve in the rubber bulb has proved sufficient to eliminate almost completely any back-flow

[1] Read before the annual meeting of the American Gastro-Enterological Association, Washington, May 8, 1933.



a b

Fig. 1a. Single contrast enema revealing feathery or shaggy outline of the cæcal and cæcocolonic margins, especially along the lateral aspects, which might be the result of inflammation, multiple diffuse polyposis, or retained fæcal material adherent to the mucosa.

Fig. 1b. The double contrast study of the same colon—note the uniform coating of barium on the mucosa of the colon distal to the hepatic flexure as contrasted with the stringy mosaic-like distribution on the mucosa of the ascending colon; at the same time, note the uniform continuity of the colonic margins of the ascending colon as contrasted with the same margins in the single contrast enema. A diagnosis of right-sided catarrhal colitis was made from these findings.

of the opaque contents into the rubber tubing during the inflation. The colon is carefully observed fluoroscopically during this time and when it is altogether filled the inflation is halted. To avoid overdistention of the colon, the air is measured, making it equal to the amount of the opaque contents of the single contrast enema. If it takes 1000 cubic centimeters of opaque mixture to fill the colon, only 1000 cubic centimeters of air are used. The Politzer bag contains 250 cubic centimeters of air; it is, therefore, comparatively easy roughly to estimate the quantity of air used. If the patient expels some air during the examination, we compensate for it by greater inflation. Since all this is done under fluoroscopic control, overdistension is avoided. We have never had greater ill-effects from inflating the colon with air than with the opaque mixture.

INDICATIONS FOR THE USE OF THE DOUBLE CONTRAST ENEMA

Kirklin and Weber have said that in many instances the double contrast enema study offers hardly more information than that of the simple barium enema. Further, that cumbersomeness and expense, joined to this doubtful superiority, preclude any advantage in its routine use. Agreed: but we confess to an inability to prophesy which case will be the exception. Besides, early or minimal lesions of the mucosa and small intraluminal growths are often completely obscured in the simple barium enema, especially in a redundant colon. It must not be forgotten either that at present our only chance to manage malignancy derives from its early recognition, or better still, in the detection of precancerous lesions. Weber has shown how beneficial to the visualization of such lesions the double contrast method can be, and Gershon-Cohen has reported it as superior to the mouth-meal method for the diagnosis of early ileocæcal tuberculosis. We have reviewed the diagnostic benefits accruing from the routine use of double contrast enema in practically every form of colonic pathology. A value potentially so great, even though unpredictable, is argument enough, we feel, for use of double contrast enema routinely.

a b

Fig. 2a. Single contrast enema revealing slight abnormal dilatation of the cæcum, considerable elongation of the transverse segment, and diverticulosis of the pelvic and sigmoid segments.

Fig. 2b. Double contrast enema study of the same colon revealing an inverted cæcum which accounts for the abnormal dilatation of the cæcum in the single contrast films. Note the presence of a small intraluminal growth in the cæcocolon just opposite the outwardly rotated valve—thus tumor mass was not visible in the single contrast films; nor were so many diverticula visible in the single contrast films.

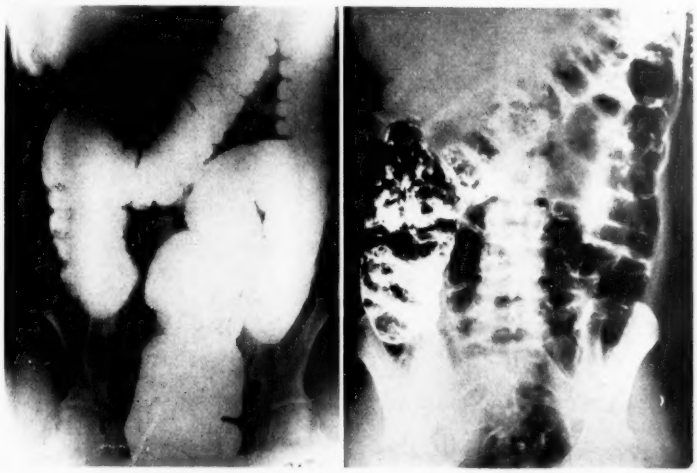
Patient refused operation in spite of the presence of occult blood in the stools and a strong suspicion that the growth in the cæcocolon was malignant. Death, 14 months later, followed by autopsy disclosed the presence of a large tumor mass of the cæcocolon as shown by these roentgen studies. The histological diagnosis was papillary adenocarcinoma.

CORRECTION OF ERRORS DUE TO INCOMPLETE FILLING, FÆCAL OR FLUID MASSES, LOCAL SPASM, MEMBRANES, AND ADHESIONS

It is too often with difficulty that defects in the colonic outlines from the simple barium enema can be designated "real" or "apparent." No matter how painstaking the preparation of the colon to prevent false filling defects by retained fæcal or fluid material, such defects occur. While they are most often found in the cæcum, cæcocolon, and sigmoid, and although they can often be displaced on palpation, they frequently necessitate a repetition of the examination before a definitive roentgenological opinion can be achieved. The double contrast enema establishes the falsity or reality of such defects by the changes or lack of changes in their positions and contours following injection of the air.

Local spasm often deforms colonic outlines making the distortion indistinguishable from real pathology. Such findings are particularly troublesome in the simple barium enema examination when the defect, *not* observed fluoroscopically, is first detected on the film. All complications of this kind are dissipated by the double contrast study. While spastic contraction may persist in the air film, it is rarely seen in the same segment in both the barium and the barium air films unless true pathology is present, in which latter case, the lesion is usually more clearly visualized in the double contrast film.

While the various congenital and inflammatory bands and membranes are never actually discernible roentgenographically their presence may be suspected as a result of the impaired mobility of the involved intestinal segments, or of their abnormal placement, or of the examiner's inability to separate adjacent loops of bowel. Occasionally, however, the coupling of these bands or membranes with the overlapping of colonic segments defies all effort to visualize the outlines and contours of the involved loops in the single contrast films. Here again, the double contrast enema



a b

Fig. 3a. Single contrast enema examination showing elongation with redundancy and dilatation of the pelvic, sigmoid, and rectal segments—also shagginess and irregularity of the cæcal and cæcocolonic margins. A suggestion of small circular filling defects is present in the midtransverse colon near the upper margins.

Fig. 3b. The same colon studied with the double contrast method. Note the regular continuity of the margins of the ascending colon with the presence of myriads of small, more or less circular filling defects in the ascending, transverse, and sigmoid segments. Also, the stringy distribution of the residual coating of barium impregnated mucus on the walls of the descending and pelvic segments.

A diagnosis of diffuse polyposis of the colon with mild mucocolitis of the descending colon was made. The sigmoidoscopic examination revealed the presence of diffuse polyposis and mucus was persistently found in the stools.

clarifies the picture. In consequence, the colonic segments are clearly outlined; the fluid levels always discernible; and the restricted mobility of the intestinal loops, no matter how displaced or how firmly joined together, always visible.

DIFFERENTIATION BETWEEN TRUE AND FALSE COLITIS

After the evacuation of the barium enema, the normal colon retains about 25 per cent, or less, of the barium. This residue, upon fluoroscopic examination, is usually distributed in the cæcum, upper descending colon, and often in the sigmoid and rectum. After the air injection a thin layer of suspension may be seen coating the mucosa. This gives a sharp, uniform, etched colonic outline contrasting with the denser intraluminal air zones.

Variations in the barium coating indicate colonic irritation. They are, in all probability, due to the amount of mucosal transudate or exudate produced by the excitant of the colonic disturbance. The milder irritations present interruptions in the continuity of the etching lines. In others, a plaque-like distribution of the residual film of barium on the colonic mucosa is noticeable. More advanced cases of mucosal irritation produce greater irregularities in the distribution of the barium and often adopt a mosaic or lace-like design. At times, detached casts of impregnated mucus, or long strings of mucus lying free in the lumen, are visible. Changes such as these are associated with different grades of true inflammation. In contrast, irritable colon, the result merely of spasm, does not produce any variety in the distribution of the residual opaque coating of the mucosa.

DIVERTICULOSIS AND DIVERTICULITIS

While the simple barium enema readily reveals the presence of diverticula, the double contrast method permits refinements well

worth the additional effort. In the plain barium enema, only those diverticula may be seen which project in the plane at right angles to the rays. Those in other planes will be obscured by the barium in the colon. The double contrast enema allows visualization of these diverticula in addition to the marginal ones. It thus gives a more complete picture of the number of diverticula and of their distribution. Too, in the presence of a diverticulitis, the exudate and transudate may so diminish the tenacity of the mucosal secretion that the barium will not adhere to the walls of the inflamed diverticula, producing signs similar to those described under true colitis.

ILEOCÆCAL TUBERCULOSIS

Sampson has painstakingly elaborated a mouth meal roentgen examination for the diagnosis of ileocæcal tuberculosis. These studies involve examination of the colon at frequent intervals between the fourth and tenth hours after ingestion. In addition to the multiple, expensive examinations, the interpretation of the roentgenograms presents a difficult problem. The normal variation in motility of the ingested column through the intestinal tract is quite wide. In early cases the frequent inconstancy of the localized hypermotility often results in doubtful evidence upon which to base a positive diagnosis.

Irritability in the terminal ileum and cæcum, where tuberculosis is most frequently localized, is very easily uncovered. The presence of hyperperistalsis, antiperistalsis, pain, tenderness, and changes in the outlines and contours of the terminal ileum and colon can all be quickly, thoroughly, and convincingly demonstrated by fluoroscopic and roentgenographic examination by means of the enema methods. When we add to this the findings of the double contrast films, the diagnosis can always be established and an accurate idea gained of the exact extent and degree of pathology.

In very early cases, abnormal peristaltic phenomena in the affected segments of the terminal ileum and colon are always seen fluoroscopically, and the pseudo-filling defects due to these are always visualized in identical segments in both films. Unfortunately, the visualization of ulcers is seldom possible, but considerable irregularity in the distribution of the residual opaque contents in the ulcerated areas is always the rule and stands out in sharp contrast to the normal segments of the colon where the residual opaque coating is uniform. The various changes in the appearances of the colon in the double contrast films have already been described in detail.

NEOPLASMS

The double contrast method has found its greatest usefulness in making visible intraluminal polypi and minimal neoplastic lesions of the mucosa, so small as to be generally overlooked. Weber has pointed out how difficult it is consistently to visualize these types of colonic lesions in the simple enema. If the principles stressed by Moore for gastric polypi can be applied to the colon, occasional recognition of a polypoid growth can be made with the simple barium enema, but only if the tumor is large. In some instances the barium column fluoroscopically may show a momentary split as it passes the new-growth—a finding which may be easily overlooked. In such cases the double contrast enema becomes of inestimable aid. In the barium filled colon small fungating or papillary growths may be completely obscured. Following the air injection these masses stand out in bold relief as areas of increased density in the clear air zones between the sharply etched colonic walls (Fig. 3). We have been convinced too many times by the demonstration of *early* young neoplastic growths in the double contrast films completely unsuspected and obscured in the single contrast films not to realize the desirability of *routine* use of the double contrast enema examination. This desirability is made a *necessity* if the life of the patient and the successful surgical treatment of cancer of the colon is put above the slight additional time and cost the double contrast studies entail. We know that these studies will result in the proper diagnosis of many obscure cases of intestinal bleeding due to precancerous and early malignant growths undetectable by the ordinary single contrast enema.

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THE ETIOLOGY OF UTERINE FIBROIDS

WITH SPECIAL REFERENCE TO THE FREQUENCY OF THEIR OCCURRENCE IN THE NEGRO: AN HYPOTHESIS

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IN a recent communication we attempted to show that ovarian dysfunction, resulting in follicular cystic changes in the ovaries, was a possible factor in the causation of fibroids. It is a generally accepted fact that hyperplasia of the endometrium is caused by estrin stimulation, unopposed by any corpus luteum influence, and with a possible anterior pituitary factor in the background. That this excess estrin stimulation, or hyperestrinism, should be limited to a single uterine layer, the endometrium, did not seem reasonable, especially since the uterus as a whole is involved in the reproductive process. It seemed logical to us that the myometrium should also be involved, especially if there be pathological stimulation to this myometrial layer at the same time that the endometrium is being abnormally stimulated to hyperplastic formation. But, since the rate of growth of fibromyomata is not exceedingly rapid except in pregnancy, malignancy, and possibly in youth, their appearance would be slower than the hyperplastic endometrial changes. Hence, it might be concluded that the unopposed action of estrin on the uterus would result (1) in immediate endometrial changes, characterized by hyperplasia, and (2) in more latent myometrial pathology in the nature of fibromyomatous growths.

Using this hypothesis as a basis in this recent paper, we analyzed 150 cases of white women with hyperplasia of the endometrium, associated with follicle cystic changes, and we offered the findings of the ovaries, endometrium, and myometrium as evidence substantiating a cause and effect relationship between ovarian follicle cyst formation with hyperestrinism, hyperplasia of the endometrium, and fibromyomatous growths in the myometrium.

We feel that any explanation that can be offered as a possible cause of uterine fibroids must take cognizance of the frequency of their occurrence in the negro woman. That race is an etiological factor has not been scientifically proved, but in Charity Hospital, New Orleans, where the annual admission of white and colored patients is about equal, uterine fibromyomata were noted nine times as frequently in the colored woman as in the white. Balloch describes this type of growth as a racial peculiarity, although there is a general impression extant that these tumors are unknown among primitive savage tribes. Moreover, Mouchet and Gérad remark that the fact which impresses medical missionaries in Central Africa is the rarity of neoplasms in the blacks, and that one is forced to believe that the negro presents a particular immunity to this affection.

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In addition, Surmont and Sava, after a lifetime study of the black race in Africa not touched by civilization, agree that there is a rarity, or even absence, of malignant tumors outside the white races. They were able to report only 5 cases of fibroids of the uterus, and 3 cases found at autopsy were associated with ovarian follicle cysts. Why there should be any relationship between the development of uterine fibroids and the advancing civilization of the negro woman is difficult to understand, unless, as will be emphasized in this paper, ovarian dysfunction, resulting from chronic pelvic infection, usually gonorrhœal, plays an etiological rôle.

Those of us who have been raised in the South, side by side with the negro, have been imbued with the fact of the prevalence of gonorrhœa in the negro race, and those of us who have practiced medicine among the negroes have a full realization of the basic truth of this teaching. Of 6,918 patients with pelvic disease admitted to Charity Hospital, 69.1 per cent were colored. A second pertinent observation on the colored woman is the frequency of fibroids; in Charity Hospital of 2,991 cases of fibroids, 89.9 per cent were in the negro woman, although the total gynecological admissions were only slightly greater in the negro than in the white. Miller comments that from one-third to one-half of all colored women over 50 years of age present this type of growth, while as far back as 1872 Peaslee noted that few negro women over 40 years of age who died at the House for Colored Incurables in New York were free from this growth.

The great frequency of occurrence of these two diseases in the negro, chronic pelvic inflammation, usually specific, and uterine fibroids, is so overwhelming that it is natural to attempt to associate one with the other, but owing to the fact that it is characteristic of the negro to bear pain rather than place herself in the hands of a physician, or in a hospital, the two conditions are often so extensive and complicated that it is difficult to determine which is the primary pathology. Before making an analytic study of the association of these two conditions, therefore, it may be instructive to look into the racial heredity of the negro, since, as already stated, it is difficult to understand why there should be any relationship between the development of uterine fibroids and the advancing civilization of the negro woman.

Matas, in 1896, wrote a masterly description of the surgical peculiarities of the negro, and from this article we have mainly abstracted the following historical and racial characteristics: With very few exceptions, the negroes of our North American continent are directly descended from the black slaves imported from Africa during the slave traffic. This trade drew from the diversity of tribes that inhabited the vast African areas along the coast, and in consequence a great variety of negro types were introduced into the American colonies. These types, however, have gradually fused, so that the present typical American negro is a truly composite type which has incorporated in it all the generic characteristics of the West African tribes. At present there remain comparatively few of the pure black type, since according to the 1928 census one-fifth of all American negroes exhibit some strain of white or Aryan blood. Yet, to those of us who are not ethnologists, the present American negro exhibits overwhelmingly the characteristics of the Guinea (Congo, Louisiana) type, that is, wooly hair, black skin, thick lips, a broad flat nose, prognathous jaws, a narrow and receding forehead, a slender waist, high hips, slender and massive feet, which are rounded at the bottom. The two other pure negro strains that are occasionally seen are the Yoloffs, characterized by wooly hair, jet-black skin, a fine form and strictly European features, and the Caffres, who exhibit wooly hair, a blackish-brown complexion, and have both fine features and form.

What has been the effect of the infusion of white or Aryan blood into the original pure negro type is a difficult question to answer. Some information is gained from Quatrefages, who, in the *Human Species*, translated into less technical phrases, says when the disturbing factors, or the cause of a disease or injury, act upon a fundamental element, the same causes will produce fundamentally similar effects; when, on the contrary, this action is exercised upon the acquired element of each

race, the same causes will produce different effects.

The diseases which were at one time so common and specific to the colored race, yaws, African sleeping sickness, elephantiasis, etc., have practically disappeared from this country, whereas the almost absolute immunity of the negro to malaria, yellow fever, scarlatina, diphtheria, gastro-intestinal diseases, nervous disorders, gout, etc.,—definite evidences of acquired racial differentiation—has been completely modified in less than 300 years, until at present the negro is almost as susceptible to these diseases as is his white brother. In short, the general comparative immunity of the negro to certain diseases in the earlier period of this country's history has been impaired by his long residence in a new habitat, and now cancer, tuberculosis, and syphilis, at one time practically unknown to this race, are exerting a deteriorating influence upon the physical stamina of a race that is possibly inadequately prepared for it. Today the negro is not only sharing the physical tribulations of the white race, but is, in reality, developing hitherto unknown morbid predispositions to certain diseases that affect the white race, and a tendency to exhibit loss of specific racial immunity to pathological peculiarities which it acquired during the original process of race differentiation in Africa.

Balloch, in 1894, was one of the first observers to call attention to fibroid processes in the dark skinned races, especially elephantiasis Arabum, keloids, and uterine fibroids. He cites purposeful keloid formation in the savage tribes as cosmetic adornment and tribal identification; we, however, have been unable to find any evidence in medical literature of the association of keloids and uterine fibroid formation. That keloids and elephantiasis Arabum are frequent findings among the savages is a known fact, but definite evidence is still wanting, as brought out by the report of Surmont and Sava, to confirm a similar frequency of uterine fibroids. In fact, the opposite opinion is generally held, that fibromyomata of the uterus are unknown among the primitive tribes, and are a disease of advancing civilization. If this be true, uterine fibroids are not the result of a racial inheritance, as postulated by Balloch, but are caused by some acquired influence. Moench, who offers localized pelvic congestion and overactivity of the ovarian hormone as a theory for the etiology of fibroids, assigns as a reason for the frequent incidence of the disease in the American negro as compared with the African black, the fact that the strict rules of sexual abstinence of the

TABLE I

Age		
Oldest	58 years	
Youngest	24 years	
Average age	36.8 years	
	Cases	Per cent
Social status		
Married	106	
Single	13	
Not mentioned	6	
Fertile	64	60.3
Sterile	34	32.
Not mentioned	13	
Menstrual history		
Menorrhagia	55	
Metrorrhagia	16	
Dysmenorrhœa	22	
Amenorrhœa	2	
Menopause	1	
Normal	16	
Not mentioned	31	
Chief complaint		
Tumor	57	
Pain	65	
Bleeding	10	
Not mentioned	6	
Myometrium		
Hypertrophied	92	
Fibrotic	25	
Not mentioned	6	
Endometrium		
Hyperplastic	38	
Atrophic	51	
Normal	5	
Not mentioned	31	
Ovaries		
Cystic	121	96.8
Fibrous	41	
Corpus luteum	4	
Dermoid cyst	1	
Both ovaries, or total ovarian tissue	85	68
Tubes		
Salpingitis	125	100
Wassermann		
Positive	28	22.4
Previous operations		
Oophorectomy		
Unilateral salpingectomy	4	
Bilateral salpingectomy	2	
	6	
Pregnant	1	
Herniorrhaphy	1	
Dilatation and curettage	2	
Appendectomy	1	

Africans make these tribes distinctly undersexed in comparison with the civilized white woman; organs below par respond to stimulation by an excessive reaction. All of this may be true, but to those of us who live in the South this theory sounds more fanciful than truthful, since an undersexed negro of pure strain is at present only a myth, and the sexual promiscuity of the negro has made sexual intercourse almost synonymous with social intercourse.

If we may conclude negatively, because of lack of positive evidence that uterine fibroids are not the result of a racial peculiarity since (1) they are present also in the white race, and supposedly not in the pure primitive stock, and (2) that no report of a definite association between keloids and uterine fibroids could be found, we are then forced to admit a relationship between fibroid formation and the advancing civilization of the negro woman. In other words, uterine fibroids are the result of an acquired influence, not of an inherent trait.

We believe that the source of this acquired influence is to be found in the chronic pelvic disease of the negro, giving rise to an inflammatory reaction around the ovary, which results in ovarian dysfunction and abnormal hormonal secretion in the nature of hyperestrinism, whose action on the uterus, as suggested, is immediate endometrial changes, characterized by hyperplasia, and more latent myometrial changes in the form of fibromyomatous growths.

Using this hypothesis as a basis, we have noted that Alsobrook reports 99.1 per cent salpingitis associated with 1000 cases of fibroids in the negro. In the present series of 125 cases of fibroid growths in the negro woman, pelvic inflammatory disease in the nature of salpingitis, oophoritis, pelvic abscesses, pus pockets, adhesions, etc., was observed in every instance. In addition, the ovaries exhibited follicle cyst formation in 121 cases, or 96.8 per cent. Table I is offered, presenting the myometrial, endometrial, and ovarian findings in the 125 cases of fibroids in negro women. Unfortunately, due to the inadequacy of the records, the condition of the endometrium was not often diagnosed microscopically, but merely commented upon grossly. We, therefore, feel that the endometrial findings as given here are of little value.

SUMMARY AND CONCLUSIONS

In a previous paper we have offered evidence from 150 cases of fibroids in white women which we believe to be convincing in support of an hypothesis that ovarian follicle cyst formation, with hyperestrin secretion, is an etiological factor in the formation of (1) hyperplasia of the endometrium, and (2) fibromyomatous changes in the myometrium, provided the stimulation is prolonged sufficiently. Because of the greater frequency of fibroids in the colored woman, we have attempted to apply this hypothesis to this race, and we feel that the ovarian and myometrial findings from 125 cases of fibroids in the negro are additional evidence which confirm the original hypothesis. Our belief is that uterine fibroid development in the white and colored woman has the same source, namely, prolonged estrin stimulation resulting from ovarian follicle cyst formation, but that the negro presents a greater frequency of occurrence of fibroids because chronic pelvic infection, resulting in ovarian damage and dysfunction, is more common in her than in the white woman, and this abnormal ovarian secretion, the stimulation of which remains permanent, is prolonged sufficiently to be the igniting factor in the development of fibromyomata.

It would seem, however, that pelvic infection giving rise to disturbed blood supply, follicle cysts, thickened ovarian capsules, abscesses, etc., is not the only source of ovarian follicle cyst formation. In the white woman, in whom chronic pelvic diseases are not so common, and especially in the white virgin, in whom pelvic infection is definitely ruled out, we believe ovarian follicle cyst formation is the result of a general glandular disturbance, inherent in the organism as a whole.

Moreover, we doubt that this ovarian damage in the white woman need necessarily be permanent. Often it is not prolonged sufficiently to cause latent fibromyomatous myometrial changes, even though the immediate hyperplastic endometrial changes be present, since we frequently, in our clinical experience, see women who in early life exhibited hyper-

plasia of the endometrium and, necessarily, ovarian follicle cysts, later pass through the normal reproductive process, and the former glandular disturbance readjusts itself.

In conclusion, we offer as an explanation for the frequency of fibroids in the colored woman, the fact that ovarian follicle cyst formation, resulting from mechanical blocking, due to a thickened capsule, or disturbed blood supply from chronic pelvic inflammation, is a frequent finding, and when once initiated the hyperestrin secretion persists, since the damage is permanent, as long as ovarian tissue remains active. On the other hand, in the white woman, ovarian pelvic inflammation is a much less frequent finding, and often the ovarian follicle cyst formation is a result of general glandular upset, and therefore is not permanent, if a glandular readjustment can be obtained.

In this fact of permanent and continuous stimulation of hyperestrinism on the myometrium, prolonged sufficiently to cause uterine fibroids, we believe there lies a convincing explanation for frequency of fibroids in the negro.

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CLINICAL SURGERY

FROM THE ROYAL WATERLOO HOSPITAL, LONDON

TECHNIQUE OF SPLENECTOMY

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THERE are many ways of performing the operation of splenectomy, and these will vary with the technique employed by the individual surgeon and the particular circumstances which call for removal of the spleen. The operation may be one of great simplicity when the organ is of normal size, or, if enlarged, when there are no binding adhesions. On the other hand, in certain conditions in which splenectomy is clearly indicated, the technical difficulties may be so great that the operation may have to be abandoned altogether. In some cases of splenomegaly the organ may be so inextricably tethered to the diaphragm and adjacent viscera that it becomes a physical impossibility to mobilize the spleen and ligature off its anomalous vascular pedicles.

There are certain features in the technique of the operation which I propose to emphasize in this article, as they are not generally appreciated, or have been somewhat neglected in descriptions of the operation.

Figure 1 shows diagrammatically the two vascular pedicles of the spleen, and the somewhat complicated visceral reflections of the peritoneum in the region of the hilum. It demonstrates the necessity of securely ligaturing and dividing the gastrosplenic omentum before dealing with the true pedicle which contains the splenic artery and vein.

It is most important to ensure that the stomach is empty and flaccid before the operation is commenced, by passing a small stomach tube and aspirating the contents. If the stomach is distended with gas or fluid it will push the spleen into an even more inaccessible position, in addition to rendering all intra-abdominal manipulations more cumbersome, difficult, and not free from danger in so much as the stomach itself may receive some injury when the uppermost portion of the gastrosplenic omentum is ligated. It is unlikely that the stomach will contain any fluid except in cases of trauma of the organ; but if an inhalation anæsthetic is being given it is usually distended with gas. A stomach tube, therefore, which has been introduced before the operation, and left *in situ* until it is completed, ensures an empty stomach, and simplifies the further steps in the operation.

There are four important stages in the operation: (1) the abdominal incision and exposure of the spleen, involving the question of choice of incision; (2) the freeing of adhesions, the mobilization of the spleen, and its delivery through the abdominal wound; (3) the methods of securely ligaturing the vascular pedicles; (4) closure of the wound and ensuring meticulous hæmostasis of the blood vessels in the anterior abdominal wall.

1. *Incision and choice of incision.* Numerous incisions have at one time or another been employed for splenectomy, but I shall describe only the four which I would myself recommend for the reasons given.

a. *Midline incision* (Fig. 2, *A*). This is indicated in cases of rupture of the spleen, as it is easy to make and easy to close, besides affording satisfactory access to the spleen and permitting inspection of the liver and the other important viscera of the upper abdomen, which may or may not be implicated. If any difficulties are encountered during the operation, a ready approach to the spleen will be obtained by cutting the left rectus muscle transversely through one of its tendinous intersections.

b. *Paramedian incision* (Fig. 2, *B*). This is recommended for the majority of cases of splenomegaly, and is one that is preferred by most surgeons. The incision does not in any way damage the rectus muscle, gives a good exposure, and subsequently a sound scar. There is, however, the drawback that the employment of this incision

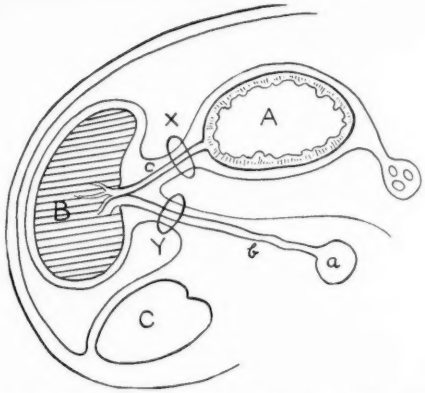


Fig. 1. Vascular pedicles of the spleen. *X*, False pedicle (gastrosplenic omentum). *Y*, True pedicle (lienorenal ligament). *A*, Stomach. *B*, Spleen. *C*, Kidney. *a*, Aorta. *b*, Splenic artery. *c*, Vasa brevia.

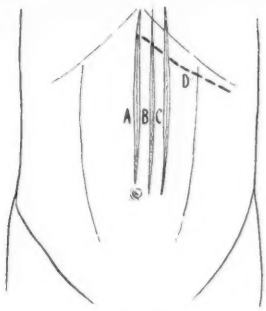


Fig. 2. Incisions for splenectomy. *A*, Midline. *B*, Paramedian. *C*, Transrectus muscle. *D*, Subcostal.

may protract the operation by a few valuable minutes.

c. *Transrectus muscle incision* (Fig. 2, *C*). This is the incision I have used in the majority of my cases. It commences over the costal margin, and proceeds vertically downward to the level of the umbilicus. It is placed at the junction of the middle and inner third of the left rectus muscle, and traverses all the structures of the anterior abdominal wall in the same plane. It gives ready approach to the spleen, and is particularly easy to sew up rapidly. I have never seen a postoperative ventral hernia develop after the employment of this incision, but I have 2 cases which show definite weakness of the inner fibers of the muscle.

d. *Subcostal incision* (Fig. 2, *D*). This incision begins at the tip of the xiphisternum, and runs obliquely outward and downward, two fingers-breadth below the costal margin. The rectus muscle and the muscles of the lateral abdominal wall are divided in the line of the incision. It is, in fact, similar to Kocher's gall-bladder incision on the opposite side, and should be employed for those cases in which splenectomy is called for in very obese patients. If this wound is carefully sutured there is no risk of subsequent hernia.

There are three important points, therefore, which should characterize all these incisions: (1) They should be large and generous, so that there is no hampering of the intra-abdominal manipulations. (2) Special pains should be taken to see that wound hæmostasis is thorough and complete. Neglect of this may, owing to the condition of the blood in such patients, lead to subsequent hæmorrhage, or a dangerous—possibly fatal—oozing. (3) Closure of the wound should be performed carefully, and tension sutures inserted as a precautionary measure against burst abdomen or postoperative ventral hernia, which are by no means infrequent complications.

2. *Freeing of the adhesions, the mobilization of the spleen, and its delivery through the abdominal wound.* As soon as the abdomen is opened the first step should be a rapid but complete exploration of the liver, gall bladder and its ducts, the pancreas, stomach, and duodenum. If not performed as a routine at this stage it may be forgotten or omitted after the splenectomy, and some important concomitant or independent intra-abdominal lesion be overlooked which will subsequently mitigate or completely destroy the benefits of the operation. It will be noticed that as a result of passing the stomach tube the stomach lies high up, tucked underneath the liver, empty and contracted. If the viscus, however, is still distended, the stomach tube should be reinserted and left in position during the remainder of the operation. Both edges of the wound are now well retracted to the right hand and to the left, and any adhesions which readily present themselves should be carefully divided and ligatured off. It is quite common to find slight adhesions between the spleen and the anterior abdominal wall, or the spleen and the transverse colon. These should be picked up and divided between artery forceps, and ligatured off before proceeding further. The spleen should then be carefully palpated, its size and consistency should be gauged, its mobility ascertained, and the presence or absence of adhesions between the spleen and the diaphragm noted, before deciding upon the next step in the operation.

A careful search should be made for an *accessory spleen* or *splenculi*. It is stated that an accessory spleen is present in 10 per cent of cases. My experience is that the incidence has been underestimated, and while in normal subjects this figure may be correct, in cases of splenomegaly and in certain other diseases of the spleen, such as essential thrombocytopenic purpura hæmorrhagica, it is very much greater. In 7 of 12 cases of essential thrombocytopenic purpura hæmorrhagica I have found more than one splenculus to be present—58 per cent. These accessory spleens or splenculi have no fixed anatomical position. They are usually found, however, at the lower pole of the spleen, in the lower half of the gastrosplenic omentum, or in the great omentum. They vary considerably in size and shape, but generally they are circular, about the size of a marble, although at other times they may be oval or disc-like. They receive their blood supply from branches of the left gastro-epiploic artery, vasa brevia, or the splenic artery itself.

If a splenculus is found at operation it should be excised in all cases except where the spleen has been removed for rupture, as it partakes of the same morbid processes or malign characteristics as its mammoth forebear, and cases are recorded in which a splenculus, after splenectomy, has grown as large as a normal spleen.[1]

The various subsequent steps of the operation will be governed by the following factors: (a) the size of the spleen; (b) the presence or absence of adhesions between the spleen and the diaphragm; (c) the length and mobility of the lienorenal ligament.

If the spleen is small or normal in size, or even somewhat enlarged, if there are no adhesions or, if any exist, they are very slight, and if the lienorenal ligament permits of some mobility of the organ, the procedure should be as follows: The lower two-thirds, or even more, of the gastrosplenic omentum is transfixed and ligatured off, the ligatures being placed nearer to the spleen than to the stomach, as it is very easy to damage the stomach or to include a portion of it in a ligature (Fig. 3).

The remaining third of the gastrosplenic omentum is transfixed and ligatured after the spleen has been delivered through the wound. The left hand is then passed behind the spleen, which is drawn away from the diaphragm and the chest wall over to the right, thus bringing the posterior aspect of the lienorenal ligament into view. With scissors or a long knife, the posterior leaf of this ligament is divided, when a further mobilization of the organ will be rendered possible. The underlying areolar tissue and fascia propria are further incised (Fig. 4), and with the finger, or a little gauze dissection, the tissues are separated, permitting of an even further freeing of the spleen.

This step is most important, and may be regarded as the key to the whole operation, as it is the lienorenal ligament which binds the spleen down in its hidden retreat in the abdominal cavity. When the lienorenal ligament is very mobile it is possible to deliver the spleen through the abdominal wound without employing this method.

3. *Methods of securely ligaturing the vascular pedicles.* The spleen is now quite free, and can easily be drawn fully through the abdominal incision. After any remains of the gastrosplenic omentum are dealt with and after the tail of the pancreas is identified and stripped away from the main vessels, the main vascular pedicle is ready to be ligatured (Fig. 5). A large, hot, moist Cripps' pad is now placed in the space that was formerly occupied by the spleen to control effectually any oozing from raw surfaces in this area. After isolating the vascular pedicle it is clamped with three large forceps (Fig. 6).

In doing this the operator places the left index finger behind the pedicle from above downward, and lifts the pedicle forward to ensure that the forceps are applied by sight, and that in their application no damage is done to the pancreas, stomach, or colon. This is the three-clamp method of Féderoff.

The spleen is then removed by severing the pedicle with a knife between the middle and distal hæmostats. The inner or medial hæmostat is then removed, thus leaving a groove or crushed area in the pedicle (Fig. 7).

Figure 8 shows the method of ligaturing off this pedicle. Two stout 20 day chromic catgut ligatures are applied to the groove and tied side by side, while each individual vessel distal to this is picked up with a hæmostat and ligatured off separately. After ligaturing the last blood vessel and removing the Cripps' pad, the appearance will be as presented in Figure 10. A wisp of adjacent omentum is drawn over the rough surface of the pedicle and held in position by a stitch or ligature, so that no raw surface remains at the completion of the operation.

In *cases of splenomegaly* in which the spleen is greatly enlarged the procedure will be different. The gastric surface of the spleen and the gastrosplenic omentum at once come to view when the peritoneal cavity is opened. The spleen lies closely applied to the greater curvature of the stomach, the gastrosplenic omentum is vertically

[1] W. McAdam Eccles and G. D. Freer. Brit. M. J., 1921, ii, 515.

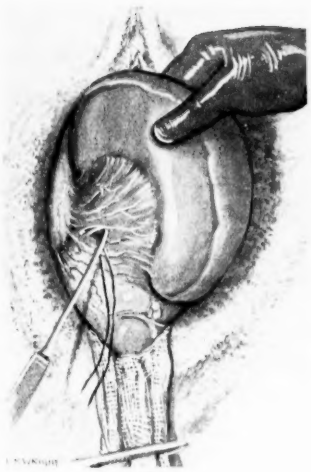
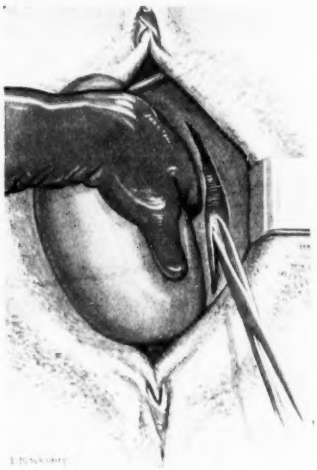


Fig. 3.



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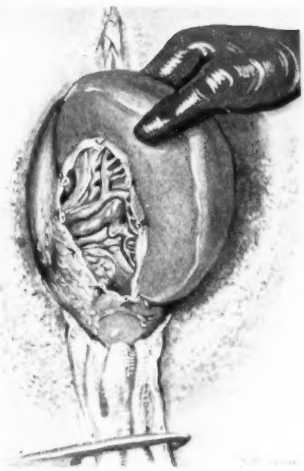

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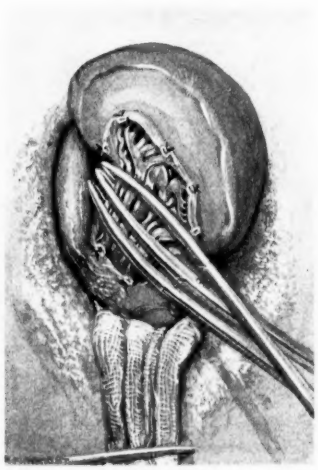

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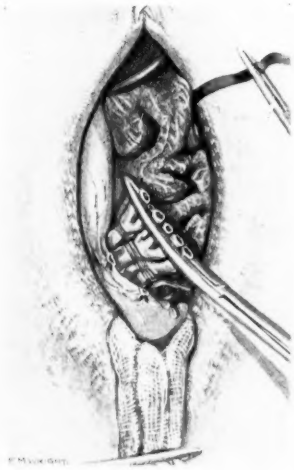


Fig. 7.

Fig. 8.

Fig. 3. Gastrosplenic omentum displayed. Ligature of blood vessels in gastrosplenic omentum.

Fig. 4. Mobilization of the spleen by division of the posterior leaf of the lienorenal ligament.

Fig. 5. The gastrosplenic omentum has been ligatured, and the blood vessels in the lienorenal ligament are shown.

Fig. 6. The three-clamp method of Féderoff for dealing with the pedicle.

Fig. 7. The spleen has been removed. The crushed grooved area which is left after the removal of the medial hæmostat is shown ready for the application of the ligatures.

Fig. 8. Two stout ligatures are applied to the crushed groove, and the individual blood vessels distal to this are ligatured off separately. Note the position of the Cripps' pad.

lengthened and horizontally shortened, and the blood vessels are enormously enlarged and increased in numbers. This enlargement is particularly prominent near the upper pole of the spleen, and is very noticeable in cases of splenic anæmia. Each of these blood vessels in the gastrosplenic omentum will have to be carefully and individually underrun with an aneurysm needle, and ligatured with thick catgut or silk.

After all the blood vessels in the gastrosplenic omentum have been dealt with, the right hand should be passed at the back of the spleen. Ad-

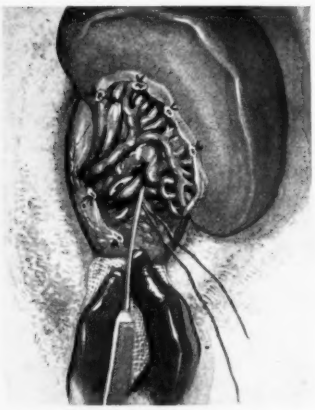


Fig. 9. The blood vessels are ligatured separately.
Fig. 10. Appearance after splenectomy. Three sutures have been applied to the bleeding points on the diaphragm.

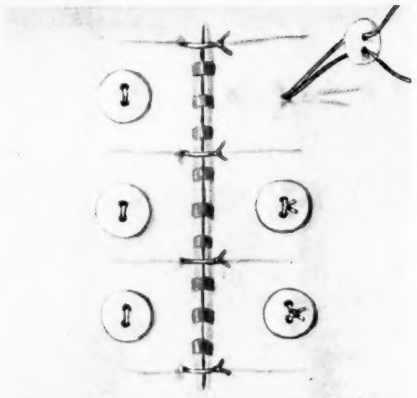


Fig. 11. Closure of the wound.

hesions here in this remote area are invisible, and will have to be separated with the finger. Bleeding may be sharp and troublesome at this stage, but the stripping and breaking down of adhesions will have to be proceeded with, as it is essential to free the organ posteriorly so that it can be drawn or hooked over to the right to display the peritoneum which forms the posterior leaf of the lienorenal ligament. As soon as the spleen has been coaxed out of its bed, and has been drawn well over to the right, the subsequent stages for the further mobilization of the spleen are similar to those described above (Fig. 4).

A hot Cripps' pad soaked in saline is packed against the diaphragm to control bleeding for the time being. As complete a mobilization as is possible should be attempted, and facilitated by turning the spleen over to the right on its pedicle as a hinge, and carefully separating the tail of the pancreas. In some cases of splenomegaly the splenic artery and vein may be enormously enlarged, friable, tortuous, and sacculated. In advanced cases of Banti's disease I have noted that their size may vary from ¼ inch to 1½ inches in diameter. Each individual blood vessel is most carefully separated, and with scrupulous care an aneurysm needle, carrying a very stout ligature, such as floss silk, is passed round it (Fig. 9), and the vessel ligatured in two places fully ½ inch apart. It is advantageous to tie off the main branches of the artery first, so that some of the blood from the spleen may be drawn back into the circulation. Each vessel that is doubly ligated is then severed between the ligatures, and this procedure is repeated step by step until the whole vascular sheath has been dealt with. The veins are particularly friable, and the ligatures may cut through them and start a very troublesome hæmorrhage. I remember one case of splenomegaly in which I had to use No. 8 plaited silk to ligature the blood vessels, as the catgut ligatures when tightened led to rupture and even severance of the venous trunks at the seat of ligation. It is possible, too, for the blood vessels to rupture proximal to the ligatures, and I have known a case in which this occurred with a fatal result. It is obvious that in these cases, because of the increased size of the pedicle, the three-clamp method is unsuitable.

After dealing with the vascular pedicle, the Cripps' pad is removed, and any oozing surfaces on the diaphragm are picked up, underrun by a "snaking" suture, and tied off. Drainage is unnecessary.

Before the wound is closed, and after complete hæmostasis is assured, three pints of warm normal saline are poured into the abdominal cavity. This often gives the patient that extra little fillip at a time when it is most needed. In cases of rupture of the spleen the blood in the peritoneal cavity can be citrated and used for autotransfusion; but, so far, I have never had to resort to this measure.[1]

4. *Closure of the wound.* The wound is closed in layers with strong catgut, and three or four tension sutures are inserted to guard against the possibility of burst abdomen or postincisional hernia (Fig. 11). The tension sutures are placed through metal or mother-of-pearl buttons so as to prevent pressure or cutting of the skin.

[1] H. Haulke. Beitr. z. klin. Chir., 1921, cxxii, 389.

FROM THE CLINIC OF THE WOMAN'S HOSPITAL

DESTRUCTION OF THE URETHRA AND LOSS OF VESICAL CONTROL ASSOCIATED WITH VESICOVAGINAL FISTULA

A Technique for Its Correction

GEORGE GRAY WARD, M.D., F.A.C.S., New York

IN 1923, I published the report of a case of reconstruction of the urethra after complete loss complicating an extensive vesicovaginal fistula (2). The technique employed was that suggested by Kelly of making a tunnel beneath the vestibule and drawing through it a flap dissected from the anterior vaginal wall with its base left attached to the vesical opening. During the discussion of this case before the American Gynecological Society, Dr. Lilian Farrar made a valuable suggestion for improving this technique by dissecting a wider flap and converting it into a tube by sutures, thus forming a canal completely lined with mucosa for the new urethra which is then drawn through the tunnel made beneath the site of the original urethra. Since then Rawls, McGlinn (1), and several others have adopted this procedure with fair success.

The difficulties to be overcome in such cases with the associated loss of vesical control are very great and the conditions to be met with are rarely alike in any two instances; consequently we must be prepared to improvise and change a given technique to suit the circumstances in each case. While we may succeed in forming a useful urethral canal, the greatest difficulty is to establish a satisfactory vesical control. The employment of a mattress stitch of linen placed at the site of the vesical sphincter and the internal meatus after Kelly's technique, and the buttressing of the neck of the bladder with buried catgut sutures is usually relied upon to obtain control, but as we all know success is not always complete or permanent.

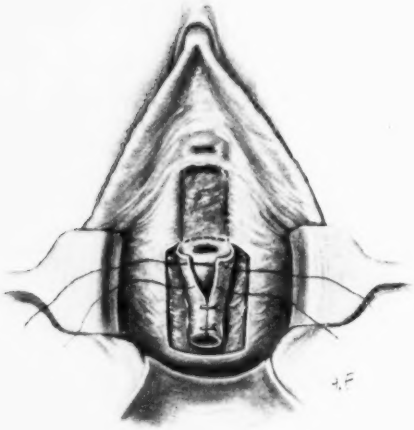
On account of the variability of the conditions to be met with, when one has succeeded in procuring a satisfactory result, the means adopted may prove of help to others. I therefore report the following case and the technique employed.

Mrs. E. H., age 26 years, married 6 years, was referred to me with the history of having had one labor in September, 1928, at full term. A difficult forceps delivery resulted in a dead baby, a vesicovaginal fistula, and loss of the urethra. She had been operated upon eight times during the past 4 years, all operations ending in failures. The last operation was in June, 1931.

I first saw her on June 6, 1932, and my examination showed a complete loss of the urethra with the exception of the external meatus, and a vesicovaginal fistula circular in shape and with a diameter of 1 centimeter situated in the trigone near the site of the internal meatus. On November 22, 1932, I operated as follows:

An incision was made on the anterior vaginal wall above the fistula outlining a quadrangular flap 2.5 centimeters wide and 3 centimeters long. This flap was dissected from the vaginal wall up to the fistula leaving it attached with the upper margins slanting obliquely to the superior border of the vesical defect. The flap was then formed into a tube by suturing the margins together after the technique suggested by Farrar (Fig. 1). A soft rubber catheter was then passed through this tube and into the bladder through the fistula. The site of the original urethra was then dissected out so as to form a deep U shaped groove and the newly constructed tube was laid in this groove and its end with the catheter was brought out of the external meatus, which had been previously denuded of mucosa, and sutured to it. The margins of the groove were then brought together over the urethral tube and sutured with interrupted sutures (Fig. 2). A Kelly mattress stitch of linen was then placed at the neck of the bladder for control and the edges of the vaginal denudation were united with interrupted sutures (Fig. 3).

The wound healed by primary union with a perfect restoration of the urethral canal and closure of the fistula. For a few days the patient had some control of the bladder, but when on her feet the control was insufficient so that in the erect posture it was unsatisfactory. I found that slight pressure on the urethra completely stopped the flow of urine, and I succeeded in obtaining a perfectly satisfactory control by using a Thomas-Hodge pessary inserted in the *reverse* position. The exact amount of necessary pressure on the urethra was easily obtained by softening the pessary in boiling water and bending the bulbous end to the required angle (Fig. 4). The patient is perfectly dry and comfortable with the pessary ever since, and she removes it for cleansing and replaces it herself whenever necessary.



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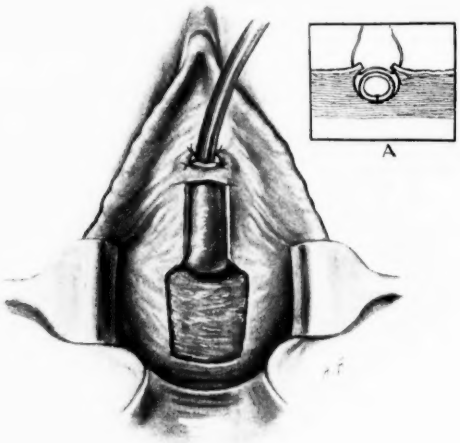

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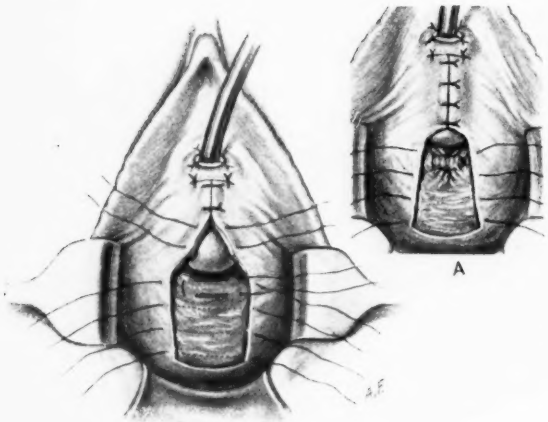

Fig. 3.

Fig. 1. Reconstruction of the urethra. The dotted line shows the site of the destroyed urethra with the external meatus intact and a vesicovaginal fistula at the neck of the bladder. As suggested by Farrar the quadrangular flap dissected from the anterior vaginal wall and sutures passed to convert it into a tube. Note the upper margins of the flap end above the fistula.

Fig. 2. A catheter is passed through the tube and into the bladder, and the new canal is laid in a deep U shaped excavation that has been made at the site of the original urethra. See insert A.

Fig. 3. The end of the canal sutured to the external meatus, and the margins of the excavation brought together with sutures over the new urethra. A mattress stitch (Kelly) is placed at the neck of the bladder. Insert A shows the mattress suture tied, and the sutures placed to close the vaginal denudation.

In this case the formation of a groove or ditch in which to place the urethral tube proved a far more satisfactory technique than to make a tunnel posterior to the vestibule. The original site of the urethra in these cases is largely cicatrical tissue in most instances, and there is danger that the vaginal surface of the tunnel may slough out on account of an insufficient blood supply. I believe that the formation of a groove as a bed for the new urethra permits of a more perfect and more certain result than the tunnel operation.

The employment of some form of pessary to control the urine by pressure has been advocated by many writers, but the general opinion has been that it is an unsatisfactory method and difficult to apply. The use of a Thomas-Hodge pessary with its thick bar in the *reverse* position I have not seen suggested before, and as its employment and adjustment are so simple and proved to be so satisfactory in this case, I believe that it is worth a trial in endeavoring to give these unfortunate patients relief.

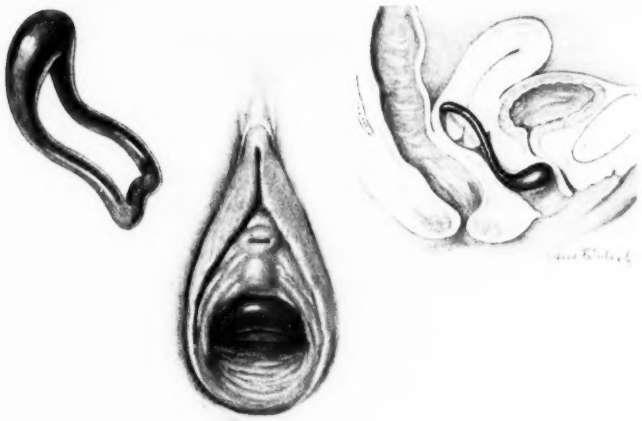

Fig. 4. Thomas-Hodge pessary placed in *reverse* position, the end having been bent to give the correct amount of pressure to insure vesical control.

Complete destruction of the urethra is a comparatively rare condition, yet McGlinn reports that seventeen articles on reconstruction of the female urethra have been published in the past 3½ years, and a number of successful results have been reported. In spite of the difficulties to be overcome in these cases, I believe that an attempt to correct the condition should be made before resorting to the somewhat radical procedure of Coffey.

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THE PELVIC OUTLET—ITS PRACTICAL APPLICATION

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TO comprehend the pelvic outlet, correlation with an area more readily understood is a distinct advantage. Knowledge concerning the outlet removes a great degree of uncertainty and substitutes a feeling of confidence. The anterior abdominal wall is easily dissected and amply described in anatomical textbooks, so an attempt will be made to correlate the pelvic outlet with it; the outlet being difficult to dissect and vaguely described in anatomical textbooks.

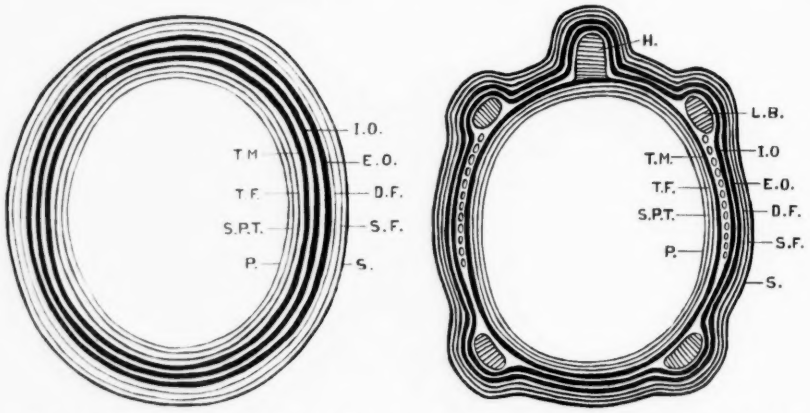
In order to facilitate a perception of the abdominal and pelvic walls, the layers of the abdominal wall will be reviewed and an attempt will be made to trace the corresponding layers to the inguinal region and to the pelvic outlet. Such a description should enable the operator to work on the pelvic outlet with the same confidence with which the abdominal wall is incised or repaired.

In an effort to avoid the confusion arising from the use of the several terms applied to the same structure, an outline will be presented into which the readers' own terms may be interpolated, thereby facilitating the reading of the description without the addition of explanatory names throughout the text.

Gallaudet has shown that all voluntary muscle is covered by a distinct layer of supportive structure called fascia. On flat muscle this structure is shaped like a sheet, while on elongated muscle the fascia envelops it as a sheath.

Involuntary muscle, however, due to its function of distensibility could not very well be covered by a distinct sheath, the purpose of which is to maintain form. It is, therefore, covered by a layer of fibro-areolar tissue which contains varying quantities of fat elastic tissue and smooth muscle, the purpose of the fat being to protect the viscus from pressure against resistant structure, and the involuntary muscular fibers to maintain the tone of the buffer layer. It is the author's belief, that the involuntary muscular fibers hypertrophy and may take on the function of a supporting tissue, when additional support is required. In a nullipara, such as Goff describes, the structure may be quite negligible, yet with a multipara in which additional support is required, definite bands of hypertrophied tissue may be noted.

To facilitate a comprehension of the abdominal, thoracic, and pelvic layers, let us consider in Figure 1 that the chest, abdomen, and pelvis are bounded by a layer of muscle which is covered by a distinct sheath of restraining tissue known as fascia. Superficial to the outer layer and deep to the inner layer of fascia is a layer of fibro-areolar tissue containing varying quantities of fat, elastic



Figs. 1 and 2. *S.*, Skin, *S. F.*, superficial fascia, *D. F.*, deep fascia, *E. O.*, external oblique muscle, *I. O.*, internal oblique muscle, *T. M.*, transversus muscle, *T. F.*, transversalis fascia, *S. P. T.*, subperitoneal fibro-areolar tissue, *P.*, peritoneum, *L.B.*, limb bud, *H.*, head.

tissue, and smooth muscle. The outer layer is called the subcutaneous layer, while the inner layer is called the subperitoneal fibro-areolar layer. Bounding the entire structure is a superficial protective layer, the skin, and an innermost protective layer, the peritoneum.

The muscular layer, through a process of splitting, in man, becomes three layers, each of which is covered by a distinct sheath of fascia. The superficial layer of muscle is called the external oblique; the intermediate layer, the internal oblique; while the innermost layer is called the transversus. The fascia applied to the external oblique muscle is naturally deep fascia and should be called external oblique fascia, just as the fascia covering the transversus abdominis muscle is called the transversalis fascia. The intermuscular layers, while not well developed in the abdominal wall, are very distinct in the pelvic outlet. This is due, perhaps, to the assumption of the erect posture, together with the absence of a tail, which by flexion would add additional support to the outlet.

In Figures 2 and 3 areas of osseous tissue will be seen superficial to the transversus muscle. The growth of the osseous tissue breaks the outer layers into individual muscles which are applied to the osseous projection, forming thereby the extremities, head, chest, and pelvis. In the chest, the layers are distinct and are called the external and internal intercostal muscles. One can readily remember the direction of these muscles, because they correspond to the layers of the abdomen and as such have a similar direction; the general direction of the external sheet being medially and distally, while the middle sheet courses proximally and medially. Occasionally, one will see a thorax in which several ribs have fused and by like analogy the bony pelvis may be considered to be a fusion of five sacral ribs; the gluteal muscles corresponding to the external oblique layer, while the ileopsoas corresponds to the internal oblique layer. A continuation of the transversus abdominis forms the levator and a proximal medial offshoot carries with it the underlying layers and forms the diaphragm, which divides the thoracic and abdominal cavities.

In the perineum, Figure 3, the external oblique layer breaks into functioning strands of muscle, which have definite function and as such have been called the ischiocavernosus, bulbocavernosus, superficial transverse perineal, and the superficial layer of the external anal sphincter muscles. The external oblique fascia covers and unites each individual muscle, although anatomical textbooks lead one to believe that Colles' layer lies adjacent to the muscle, rather than superficial to the fascia. This is perhaps due to a compensatory hypertrophy of the deep layer of the superficial fascia, which overshadows the thinned deep fascia covering muscles applied to erectile tissue.

The internal oblique muscle continues across the pelvic outlet as a distinct sheath; it is, however, perforated by the anus, vagina, and the urethra and as such acts as sphincters for these structures. The fascial coverings of this muscle have hypertrophied and are called the superficial and deep layers of the triangular ligament.

The fascia applied to the transversus muscle, which in the pelvis is called the levator ani, is the supra-anal and infra-anal fascia.

After a generalization which suggests a working plan for a more detailed study of the pelvic outlet, we are bewildered in our attempt because of the inaccessibility, due to the overlying soft tissues and the hypertrophied tuberosity of the ischium, together with the attachment of the gluteus maximus to the coccyx, which places the musculofascial outlet at a confusing level, bounded by ischiorectal fossæ. It may, therefore, be advisable

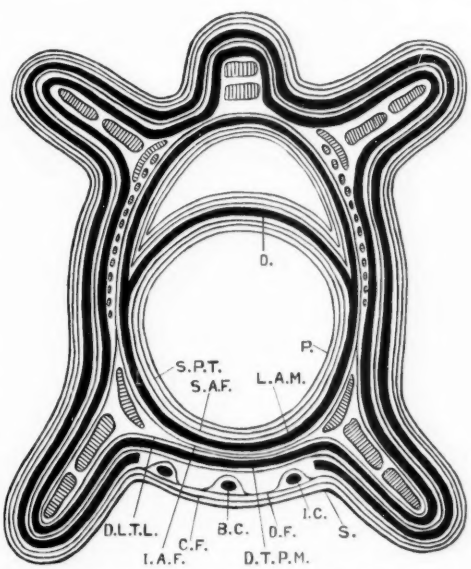


Fig. 3. *D.*, Diaphragm, *P.*, peritoneum, *S. P. T.*, subperitoneal fibro-areolar layer, *S. A. F.*, supra-anal fascia, *L. A. M.*, levator ani, *I. A. F.*, infra-anal fascia, *D. L. T. L.*, deep layer triangular ligament, *D. T. P. M.*, deep transverse perineal muscle, *B. C.*, bulbocavernosus muscle, *I. C.*, ischiocavernosus muscle, *D. F.*, deep fascia, *C. F.*, Colles' fascia.

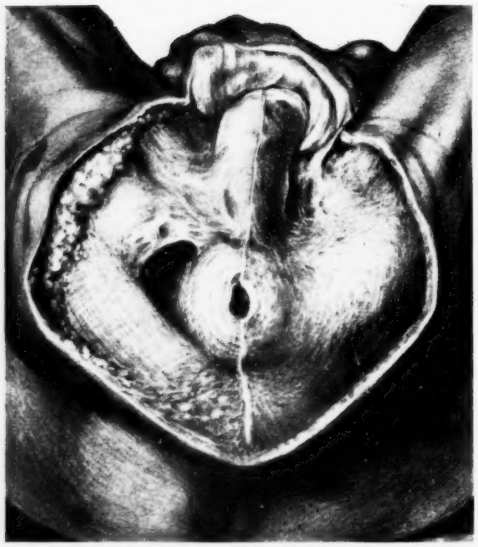


Fig. 4. The superficial layers of the outlet.

to study first, the superficial layers of the outlet of a male such as Figure 4, and later the deeper layers of a female.

On the right, the skin and the superficial layer of superficial fascia have been removed, thus exposing the deep layer of the superficial fascia which is known as Colles' layer. This layer is

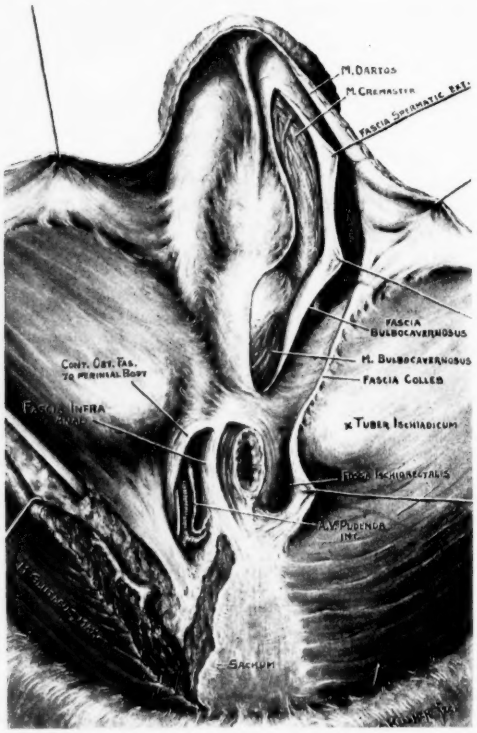


Fig. 5. The deeper layers of the outlet.

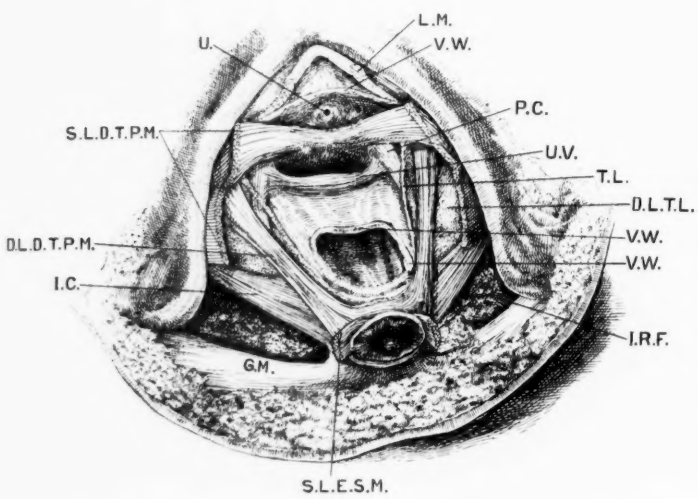


Fig. 6.

Fig. 6. *L. M.*, Labia majora. *V.W.*, vaginal wall, *U.*, urethra. *S. L. D. T. P. M.*, superficial layer deep transverse perineal muscle, *D. L. D. T. P. M.*, deep layer deep transverse perineal muscle, *I. C.*, ileococcygeus muscle, *G. M.*, gluteus maximus, *P. C.*, pubococcygeus. *U. V.*, urethrovaginal bundle of levator, *T. L.*, triangular ligament, cut edge, *D. L. T. L.* deep layer triangular ligament. *V. W.*, vaginal wall, *I. R. F.* ischiorectal fossa, *S. L. E. S. M.*, superficial layer external sphincter muscle.

seen to stretch across the arch of the pubic and ischial bones and to be intimately attached to the rami. Anteriorly it is continuous with the corresponding layer of Scarpa and on the scrotum, blends with the dartos. Posteriorly it fills in the ischiorectal fossæ and then blends with the superficial fascia of the thigh. In the region of the transverse perineal muscle, it becomes adherent to the fascia covering this muscle, thereby forming a septum which prevents the extravasation of urine posteriorly, should the urethra be ruptured through the bulbocavernosus muscle and its fascia.

On the left, Colles' layer has been removed, thereby exposing the deep fascia covering the superficial perineal muscles, which includes the superficial layer of the external anal sphincter. Lateral to the sphincter, the infra-anal fascia is seen. (It represents the attenuated fascia of the external and internal oblique muscles, brought about by the concentration of the muscular layer to form the external sphincter, as well as the transversalis fascia, on the levator.) Yet the area is mystifying; however, by dividing the gluteus maximus (Fig. 5) from its attachment to the coccyx and the sacrum and later from the sacrotuberous ligament, a less confusing plane of the pelvic outlet is reached, particularly if one realizes that the ischial tuberosity is merely an osseous hypertrophy due to traction by the hamstring muscles and consequently projects distal to the muscular outlet. The ischiorectal fossæ by this procedure are shallow and it is noted that the so called free edge of the triangular ligament is merely an elevation of the external and internal oblique fasciæ as the vessels course medially, distally, and anteriorly to the perineal body from the internal pudendal vessels. Attention is called to the fact that the so called free border does not run transversely, but follows a graceful curve, the convexity of which is directed anteriorly. The practical importance of this anatomical relationship will be stressed later.

The perineal portion of the external oblique fascia can now be traced laterally to the adductor muscles of the thigh; posteriorly, to the anus and the gluteal muscles; anteriorly, over the bulbous perineum to the external inguinal ring, where in the male it becomes the external spermatic fascia covering the cord. Medial to the external inguinal rings it is continuous with the fascia of the external oblique muscle. Lateral to the anus it becomes continuous with the infra-anal fascia.

The removal of the deep fascia reveals the superficial layer of muscles composed of the cremaster, bulbocavernosus, ischiocavernosus, superficial transverse perineal, and the superficial layer of the external sphincter of the anus. In the female, the structures are identical, with the exception that the bulb is perforated by the vagina, which divides it into two lateral bulbæ, communicating anteriorly.

In the female (Fig. 6), the deep fascia (external oblique) and the superficial muscles, including the bulb, have been removed, as well as the superficial layer of the triangular ligament (internal oblique fascia) which exposes the deep transverse perineal muscle, the superficial fibers of which have been divided lateral to the vagina and reflected anteriorly. While this subject is exceptionally well developed and presents muscle bands which are not as readily noted in the average subject, it is used to facilitate a comprehension of the pelvic outlet and at the same time emphasize the importance of intelligent development and preservation of these muscles.

The deep transverse perineal muscle is at times composed of two strata. The fibers of the superficial layer encircling the urethra are called the external voluntary urethral sphincter, while those applied to the vagina act as a vaginal sphincter. The deep layer is principally applied to the anus, some of its fibers passing anterior to the anus, to fuse with those of the opposite side, while others encircle the anus, to form the deep layer of the external sphincter of the anus. Those passing anterior to the anus to fuse with those of the opposite side, act as an accessory sphincter of the vagina.

Deep to the deep transverse perineal muscle, the deep layer of the triangular ligament can be seen. It is perforated by the vagina. Posterior to the vagina, it enters into the formation of the perineal body and from there is continued posteriorly as the fascia covering the deep layer of the external sphincter of the anus. Anterior to the vagina it has been removed to expose a deeper plane of the urethrovaginal region, containing the pubococcygeal bundles of the levator. In this specimen, a very distinct bundle of muscle stretches transversely from the levator, between the urethra and vagina, which acts as an accessory urethral sphincter. In other specimens, the bundle of muscle is poorly developed and may be replaced by a thin layer of fascia, which represents the fusion of the superior and inferior fascial layers of the levator in the midline, anterior to the vagina. This structure acts as an accessory sphincter of the urethra, the efficiency of which is increased by the ease with which the thin yielding urethra is compressed against the solid pubic bone. Lateral to the vagina, the pubococcygeal

bundle reinforces the attenuated ileococcygeus and sends a few fibers into the vagina and into the posterior perineal body.

The fascia covering both surfaces of the levator runs to the midline posterior to the vagina and becomes a component part of the perineal body and as such is involved in perineal lacerations. On the lateral and posterior walls of the anus the levator inserts between the external voluntary and the internal involuntary sphincters. It acts as an accessory voluntary sphincter, both by compressing the rectum and by angulating it anteriorly.

To recapitulate, the three muscular layers together with their fascial covering are perforated by the urethra, the vagina, and the rectum. In many subjects, the muscles are poorly developed and the fascia of a flaccid quality, not unlike the structures composing a flaccid abdominal wall. Such structures, if unlacerated, are further relaxed by distention, thereby decreasing their function.

Let us turn to the rigid outlet of the pelvis, which is, roughly, diamond shaped. It is bounded anteriorly by the body of the pubic bone, and the arch of the pubic and ischial bones. Posteriorly, it is bounded by the sacrotuberous ligaments and the sacrum. The area is lessened by the extension of the coccyx anteriorly from the sacrum; but it, like the soft structures, may be broken and damaged as the head is forced through the rigid outlet thereby permitting delivery of the child, but with what damages to the mother?

Before considering such damages, let us direct our attention to the sacrotuberous ligament (Fig. 5) which stretches from the lateral border of the sacrum to the tuberosity of the ischium. The sacral extremity of the ligament is proximal and medial to the ischial extremity. A descending occiput posterior is deflected into the oblique diameter by the promontory of the sacrum and on striking the sacrotuberous ligament, the oblique occiput will meet less resistance by rotating anteriorly. By rotation it exerts pressure against the spine of the ischium, which might account for the characteristic low back pain of an occiput posterior. The presenting part of an oblique occiput anterior is anterior to the ischial spine and consequently rotates less painfully, on the inclined plane of the ischium. One will note that a wide sacrum and a narrow interischial diameter will predispose to a persistent posterior position, due to the lessened resistance against an oblique head which rotates posteriorly.

Granting that the head passes the rigid outlet, nature has provided the hormone relaxin, which increases the elasticity of the soft parts, so that in retracting over the passing child undue lacerations do not result. The quantity of the hormone seems to diminish as the later years of child bearing approach. Then again there is the character of the tissue itself, some tissue is sclerotic and refuses to dilate, while another tissue will relax so completely that it fails to involute.

In an effort to raise the standard of the pelvic outlet *in a multipara*, let us consider the possible damages to the musculofascial layers and other structures and so direct our effort to prevent or minimize such injuries. The following may possibly be damaged: (1) gluteus maximus, (2) coccyx, (3) coccygeus muscle, (4) pudendal vessels, (5) deep transverse perineal muscle and triangular ligament, (6) posterior perineal body, (7) vagina, (8) anterior perineal body, (9) levator ani, (10) para vaginal fibro-areolar tissue, (11) bladder and paravesical fibro-areolar tissue, (12) rectum and pararectal fibro-areolar tissue.

Gluteus maximus. Turning to Figure 5, we observe the attachment of the gluteus maximus to the side of the coccyx. In a narrow outlet, especially if the coccyx is displaced, it is possible to injure one or the other of the glutei; while not a serious injury it may be a factor in the annoying, low spinal discomfort of the mother. Flexion of the thighs increases the tension of the glutei; thereby narrowing the posterior outlet, while extension of the thighs relaxes the glutei. Undue extension, however, narrows the bony outlet. A position, therefore, between extension and flexion is to be preferred.

Coccyx. The importance of the coccyx cannot be overstressed, particularly since it serves as an attachment for the glutei, the levators, coccygei, and the external sphincters of the anus. Protection from damage is afforded by the neutral position referred to, for the protection of the glutei. The absence of a regulated anæsthetic predisposes to such damage.

Coccygeus muscle and the sacrospinous ligament. One or the other or both of these may be torn from their insertion into the coccyx, as the coccyx is displaced posteriorly, particularly in a precipitate delivery or during an uncontrolled anæsthesia. Undue flexion of the thighs increases the tension on these muscles and ligaments. A well placed perineotomy and a neutral position tend to prevent such damage.

Pudendal vessels. In Figure 5, the pudendal vessels are shown leaving Alcock's canal of the obturator fascia, to course anteriorly, medially, and distally to the posterior perineal body. Such a course elevates the deep fascia of the musculo-

CORRESPONDING LAYERS OF ABDOMINAL WALL AND PELVIC OUTLET

Chest	Abdomen	Scrotum	Pelvic outlet	Anus
Skin	Skin	Skin	Skin	Skin
Subcutaneous layer	Camper's layer	Dartos	Camper's layer	Corrugator cutis ani
	Scarpa's layer		Colles' layer	
Fascia external intercostal	*Fascia* external oblique	*Fascia* external spermatic	*Fascia* superficial perineal	*Fascia* superficial layer external sphincter
Muscle external intercostal	Muscle external oblique		Muscle superficial perineal	Muscle superficial layer external sphincter ani
Fascia external intercostal	*Fascia* external oblique		*Fascia* superficial perineal	*Fascia* superficial layer external sphincter
Fascia internal intercostal	*Fascia* internal oblique		*Fascia* superficial layer triangular ligament	*Fascia* deep layer external sphincter
Muscle internal intercostal	Muscle internal oblique	Muscle cremasteric (middle spermatic)	Muscle deep transverse perineal	Muscle deep layer external sphincter ani
Fascia internal intercostal	*Fascia* internal oblique		*Fascia* deep layer triangular ligament	*Fascia* deep layer external sphincter
Fascia transversus thoracis	*Fascia* transversus abdominis		*Fascia* infra-anal	*Fascia* infra-anal
Muscle transversus thoracis	Muscle transversus abdominis		Muscle levator ani	Muscle levator ani
Fascia transversalis	*Fascia* transversalis	*Fascia* internal spermatic	*Fascia* super-anal	*Fascia* supra-anal
Subpleural layer	Subperitoneal layer	Subperitoneal (innermost spermatic)	Subperitoneal (fascia endopelvina)	
Pleura	Peritoneum	Vaginal process	Peritoneum	

fascial outlet and forms the so called free border of the triangular ligament. Within this fold is contained the superficial transverse perineal muscle; it is, however, not always present. Your attention is called to the crescent, rather than transverse, shape of this ridge.

Unless the position of the perineal body is deliberately localized, it is usually placed too far posteriorly. Figure 5 places it in the interischial diameter, which is the diameter through which the biparietal diameter of the fetal head must pass. This means that to permit delivery of the head anterior to the biparietal diameter of the child, the perineal body must be displaced considerably posterior to its normal position. Should the pudendal vessels to the bulb run transversely, they would be torn by such a change, unless they were sufficiently tortuous to permit such extension. Nature, however, has provided for this displacement of the perineal body, by so placing the vessels that posterior displacement of the perineal body relaxes rather than increases their tension.

Triangular ligament and deep transverse perineal muscle. The vaginal passage is much larger at its proximal end than at its distal end. An additional factor in narrowing it, is the various layers of the muscular outlet which it must penetrate. The opening of the vagina is so disguised by the labia and superficial tissue, that it is difficult to visualize. However, it may be compared to the opening of an umbilical hernia, which perforates the muscular and fascial coverings of the anterior abdominal wall. The vagina likewise perforates the levator ani, the deep transverse and superficial perineal muscles and their fascial coverings. The urethra and the anus likewise perforate the musculofascial sheets. The septum which divides the anus from the vagina is called the posterior perineal body. Anteriorly, between the vagina and the urethra is a similar septum, called the anterior perineal body.

Delivery of the head forces the vagina to the lateral walls of the pubic arch, so that injuries to the musculofascial outlet may be many and varied. Attention, however, is directed to undue relaxation of the outlet which, because of the erect posture, is very bothersome; also to injuries of the anterior and posterior perineal bodies which will be discussed individually because of their great importance and frequency of injury.

Posterior perineal body. One readily perceives how easily overdistention by a descending head may break into the anterior and posterior perforations of the perineum. In Figure 6, as the deep layer of the transverse perineal muscle is forced laterally by the delivering head, laceration may occur in many places; should the laceration be in the midline, the sphincter will be involved. So it may be advisable to consider the external sphincter with injuries to the posterior perineal body, particularly in those individuals in whom the connection between the deep transverse perineal and the deep layer of the external sphincter is maintained. In other subjects the external sphincter has no muscular connection with the perineal body, yet the continuity of the fascia cannot be denied. It is to this latter group that the classification first, second, and third degree lacerations of the sphincter have been applied. The anatomical continuity of the deep layer of the external sphincter with the deep transverse perineal muscle, predisposes to injury of the deep sphincter fibers; such a laceration is unnoticed unless it is sufficient to involve the superficial layer of sphincter muscle, which is derived from the superficial muscle sheet which has broken into five individual perineal muscles.

Vagina. The truncated shape of the vagina predisposes to lacerations or relaxation of the distal portion. Ironing out merely predisposes to subsequent relaxation, while a properly placed incision may regulate a laceration. Such an incision is not made laterally because of troublesome hæmorrhage from the vaginal plexus contained within the lateral ligament of the vagina. It is not made anteriorly because of the narrow septum and defective exposure for repair. It is much easier posteriorly as the perineum is distended; but to extend the incision on to the posterior wall of the vagina, the distention should not be too great; and unless the extension is carried on to the posterior wall, the distal opening of the vagina will not be enlarged. Such a procedure should prevent undue stretching of the vaginal wall and facilitate involution. At the same time it shortens the vagina and regulates lacerations by confining them to an area which is readily exposed and repaired. Prolonged distention is prevented by delivery with low forceps.

Anterior perineal body. Descent of the head conspicuously everts the anterior wall of the vagina and if held back by a resistant musculofascial outlet, that portion of the deep transverse perineal muscle which passes between the urethra and the vagina, will become overstretched and if improperly involuted, will greatly decrease the function of these fibers which are known as the voluntary urethral sphincter. Improper relaxation predisposes to a laceration of this structure, which may be hidden by the unlacerated vaginal mucous membrane. Protection is afforded both to overstretching and laceration by increasing the outlet with a properly placed incision (Fig. 6) and low forcep delivery.

Levator ani. Other than in a small area anterior to the urethra, the levator or its fascia runs to the midline of the pelvic outlet from the pubic bone to the coccyx. Its fibers are perforated by the urethra, the vagina, and the rectum. The pubococcygeal muscle is the term applied to the most medial fibers, which have a bony origin and seem to strengthen the thin levator sheet. From the pubococcygeus, fibers run to the midline anterior to the vagina, posterior to the vagina, and posterior to the rectum. In Figure 6, let us suppose that the coccyx is displaced posteriorly to permit delivery; such a displacement tightens the pubococcygeus and therefore draws the bundles closer to the midline, thereby predisposing to tearing.

In the case of a rigid outlet, which requires considerable anteroposterior molding, the occiput more nearly fills in the arch of the pubis and as such forces the two anterior extremities of the pubococcygeus further apart, with the result that the urethrovaginal bundle of the levator is stretched or lacerated. Attention is drawn to the fact that this muscle, while not present in all specimens, is replaced by fascia composed of supra-anal and infra-anal fascia which runs to the midline. To lessen the time that the head rests on the pelvic floor, by a properly placed incision and low forcep delivery, is important in the prevention of such an injury. Posterior to the vagina, the supra-anal and infra-anal fascia and the few fibers from the levator are involved by lacerations of the posterior pelvic floor. To control the laceration and at the same time be able to repair the division is of great importance. Those fibers ending in the anococcygeal raphé may be torn from the raphé or even the side of the coccyx by imperfect anæsthetization. Such an injury cannot be detected, due to the overlying tissues.

Paravaginal fibro-areolar tissue. While not a very dense structure it is thinned by the distention of the vagina during delivery and is certainly of less efficiency when the lateral ligament of the vagina is relaxed by a lacerated perineal body.

Bladder and paravesical connective tissue. The eversion of the anterior wall of the vagina is much more conspicuous than the eversion of the posterior vaginal wall, particularly as the anterior perineal body is reached; however, the distention

of the anterior vaginal wall and the underlying structures, either overdistends or lacerates the so called pubocervical ligament (a thickening of the subperitoneal fibro-areolar tissue stretching from the cervix to the urethra, which it encircles and then passes to the back of the pubis). Prolonged overstretching is relieved by relaxing the vaginal wall by means of a properly placed incision in the wall of the vagina which permits a more rapid delivery with low forceps.

Rectum and pararectal connective tissue. Prolonged distention of the posterior wall of the vagina may result in laceration or relaxation of the posterior vaginal wall and also the surrounding paravaginal and pararectal connective tissue.

In a previous publication the author has shown the existence of a thickening of the subperitoneal fibro-areolar layer which stretches from the anterior surface of the rectum to the posterior wall of the vagina. This structure contains branches of the middle hæmorrhoidal artery which supplies the posterior wall of the vagina. It tends to prevent anterior displacement of the posterior wall of the vagina. Laceration or stretching of the posterior wall of the vagina injures this structure, which is comparable to the pubocervical ligament, and thereby permits an anterior displacement of the lower fourth of the vaginal wall to take place.

CONCLUSIONS

The following suggestions for the relief of possible injuries to the musculofascial layers is preventive gynecology, however, unless the operator is well trained and is working in a well equipped hospital with a full operating staff, the procedure is to be condemned rather than to be recommended.

As we realize that the vagina narrows toward its outlet, it is our desire to increase the volume of the distal portion of the vaginal-anal canal if we wish to avoid injuries resulting from overdistention. Anæsthesia facilitates relaxation and when satisfactorily administered permits a regulated delivery, but in subelastic tissue anæsthesia alone is not sufficient. An incision of the wall of the vagina, which extends at least to the junction of the lower and middle thirds, increases the volume of the distal third and at the same time shortens the length of the vaginal tube through which the fetus must pass. The vagina, however, is further narrowed by the musculofascial layers of the pelvic outlet which must be incised in our attempt to prevent overdistention or uncontrolled laceration.

An incision of the outlet and the vagina cannot be made anteriorly because of the narrow anterior perineal body, which if incised would injure the urethra and because of incomplete exposure would make repair difficult. Lateral to the vagina an incision would involve the vascular structures composing the lateral ligament which when unintentionally lacerated causes troublesome hæmorrhage.

A midline incision posteriorly will divide the shelving posterior perineal body and distinctly enlarge the pelvic outlet. Such an incision, however, predisposes to a laceration of the anal sphincter because of its continuity with the perineal body. Some obstetricians have endeavored to avoid extension into the anal sphincter by incising the perineal body in the midline as far as the sphincter and then continuing laterally and posteriorly so that the extension will be continued into the ischiorectal fossa instead of the sphincter. This procedure, while avoiding extension into the rectum, may divide levator fibers attaching to the side of the rectum, which will more than likely be neglected in the repair because of the inaccessibility of these fibers. A midline incision is recommended, at most as far as the circular fibers of the anal sphincter. If more room is required it is advisable to remove the forceps as soon as the infant's chin can be held with a hand placed posterior to the anus and delivery effected; if need be, by careful pressure from above.

It is desirable to make the incision before the head has overdistended the outlet. Two clamps placed lateral to the midline at the junction of the vagina and the pelvic floor, namely on the hymen, will insure an incision through the musculofascial outlet and also the posterior wall of the vagina. The incision is carried carefully as far as the circular fibers of the anal sphincter and then the short incision on the posterior wall is continued proximally to the junction of the lower and middle thirds of the vagina. Such a procedure will relax and appreciably shorten the distal third of the vagina and enlarge the musculofascial outlet. It therefore aids in lessening overdistention and regulates lacerations which may have occurred under normal circumstances.

This study was prompted by the observation of the perineal outlets of several thousand multiparæ, which while considered normal, differed greatly from the outlets before delivery. It is hoped that this study will help to increase our understanding of this region and eventually help to give our patients more normal appearing pelvic outlets.

SUMMARY

1. Voluntary muscle is covered by a distinct restraining structure called fascia, while involuntary muscle due to its function of distensibility, is covered by a layer of fibro-areolar tissue which contains varying quantities of fat, smooth muscle, and elastic tissue.

2. When childbirth damages the normal supports, the fibrous and smooth muscle constituents of the subperitoneal layer hypertrophy and form definite strands of supporting tissue.

3. Fascial continuity is maintained, while muscle sheets may break into smaller functioning bundles.

4. The assumption of the erect posture and the absence of a tail are factors which bring about hypertrophy of the intermuscular fasciæ of the pelvic outlet.

5. The superficial perineal muscles and their fascial covering, including the superficial layer of the external sphincter of the anus, are comparable to the external oblique muscle and its fascia.

6. The deep transverse perineal muscle and its fascial coverings, the superficial and deep layers of the triangular ligament, together with the deep layer of the external sphincter of the anus are comparable to the internal oblique muscle and its fasciæ.

7. The levator and its supra-anal and infra-anal fasciæ are comparable to the transversus abdominis and its fascial coverings.

8. The three muscular layers of the pelvic outlet are perforated by the urethra, the vagina, and the rectum.

9. In the perineum, the fascia covering muscle applied to erectile tissue is necessarily attenuated. To compensate, the deep layer of the subcutaneous tissue, known as Colles' fascia, is hypertrophied.

10. Colles' layer lines the ischiorectal fossæ.

11. That portion of the levator which lies between the perforating urethra and the vagina, forms a part of the anterior perineal body and as such acts as an accessory urethral sphincter. It is frequently damaged by the passage of the head through the pelvic outlet.

12. A relatively wide sacrum favors persistent occipitoposterior presentations.

13. Overdistention of the distal one-third of the vagina may lacerate or prevent subsequent involution of the vagina and its fibro-areolar covering, as well as the fibro-areolar covering of the bladder and the rectum.

14. The posterior perineal body lies in the transverse diameter of the outlet. It must be displaced posteriorly to permit the delivery of that part of the fetal head, anterior to the biparietal diameter.

15. The pudendal vessels are relaxed by the posterior displacement of the posterior perineal body.

16. Lacerations of the outlet may be multiple and oftentimes unrecognized.

17. The pelvis may be considered to be the fusion of five sacral ribs, the glutei being comparable to the external oblique muscle while the ileopsoas and the obturator are comparable to the internal oblique layer.

18. The so called free edge of the triangular ligament does not run transversely, but follows a graceful curve, the convexity of which is directed anteriorly.

19. In measuring the pelvic outlet, the coccyx is disregarded because it may be displaced posteriorly to permit delivery, but with what injury to the muscles, ligaments, and fasciæ attached to it?

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ADENOMATOUS POLYPI OF THE STOMACH

With Special Reference to Malignant Degeneration[1]

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MANY papers have been written on benign tumors of the stomach, but much confusion still exists as to how often such tumors become malignant. Menetrier, in 1888, was probably the first to show that adenomatous polyps may undergo carcinomatous change. Stewart found that 28 per cent of polypi of the stomach were associated with carcinoma, but only 4.9 per cent of carcinomata were associated with polypi. Evidence obtained at autopsy is not conclusive, for polypi and carcinoma may perhaps occur independently in the same stomach, or if carcinoma has developed from a polyp all trace of the original polyp may have disappeared in the cancer. Brunn and Pearl, in a study of 84 collected cases, each showing three or more gastric polyps, found an incidence of only 12 per cent malignant degeneration. Meyer and Brams state that malignancy occurs in 60 per cent of cases of gastric polypi, but give no evidence to substantiate this figure. Miller, Eliason, and Wright, after searching extensively in many microscopic sections taken from adenomatous polypi, found carcinomatous change in 8 of 23 cases, or an incidence of 35 per cent. This is probably the most reliable figure to be found in the literature.

There are at the Massachusetts General Hospital clinical records of 17 cases of gastric polypi which have given symptoms severe enough to warrant surgical intervention. There are also records of 19 cases of gastric polypi in which the polyps were not suspected clinically but were found incidentally at autopsy. It is not possible to understand from the number, size, location, or pathology of the lesions why some have given symptoms and others have not, though in general it may be stated that the more numerous and the larger the lesions and the nearer they are located to the pylorus, the more likely they are to give symptoms. There was no suspicion of malignancy in the microscopic appearance of the polyps found incidentally at autopsy. By a follow-up study of the cases in which operation was done and a careful pathological review of specimens removed at operation, we believe the following 7 cases of adenomatous gastric polyps show evidence of malignant degeneration. This gives an incidence of malignancy of 41.2 per cent in polyps of the stomach which have caused severe symptoms.

E. I., M. G. H. No. 236192, male, aged 73 years, entered the hospital April 15, 1920, complaining of weakness and loss of weight of 2 years' duration. There had been no epigastric pain, nausea, vomiting, gas, anorexia, hæmatemesis, or melena. A definite non-tender mass was palpable in the epigastrium. Gastric analysis showed no free hydrochloric acid in the stomach. Gastro-intestinal X-ray showed a filling defect in the stomach which was thought to be a benign polyp. Operation was performed by Dr. Beth Vincent, who found a soft, rounded mass within the stomach, smaller than a tennis ball, attached to the anterior wall near the greater curvature. It appeared to be a polypoid growth and was removed with the cautery. Pathological report by Dr. T. B. Mallory and Dr. H. F. Hartwell was as follows: "Gross: A soft purplish red tumor, measuring 3.5 by 4 by 5 centimeters. Its surface is rough and granular and it has a soft, narrow attachment to the underlying mucous membrane of the stomach. Microscopic examination shows elongated gland tubules which are frequently branching and are lined by a single layer of high columnar epithelium. . . ." Although some areas were atypical and showed mitotic figures, the tumor was considered a benign adenoma. Eight years later, however, this patient began to suffer from indigestion and vomiting, became emaciated and died after an illness of about a year. Shortly before death he was seen by his physician, Dr. Ray T. McDonald, of Medford, who found a definite mass in the epigastrium and felt very certain clinically of the diagnosis of carcinoma of the stomach.

No operation was performed during the final illness, and there was no autopsy; hence the final diagnosis could not be confirmed by pathological examination. Although 9 years seems a long time, it is still quite possible that death took place from the development of malignant changes in atypical adenomatous cells not destroyed by the cautery or removed with the polypoid mass.

W. H. F., M. G. H. No. 287150, male, aged 55 years, entered the hospital November 4, 1927, complaining of intermittent diarrhœa of 19 months' duration. There was no pain, griping, discomfort, nausea, vomiting, or indigestion. There were no other symptoms except weakness and loss of 15 pounds in weight. Barium enema was negative. Gastro-intestinal X-ray examination showed a filling defect 2.5 centimeters from the pylorus, which was interpreted as due to an extensive polypoid growth involving the antrum of the stomach. Gastric analysis showed no free hydrochloric acid. Operation was performed by Dr. R. H. Miller on January 9, 1928. The antrum of the stomach for about 3 inches up from the pylorus was filled with a soft, movable tumor which slipped around inside and seemed to fill the lumen. Besides this there was an area of hard nodular growth on the greater curvature about 4 inches from the pylorus. Behind the lesser peritoneal cavity, in the region of the pancreas and cœliac axis, there was a firm, hard, adherent nodular mass of carcinoma. Radical operation was not possible but it seemed that the

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patient might be helped if the growth inside the stomach could be removed. The stomach was therefore opened and an irregular, soft, polypoid growth was removed. Pathological examination by Dr. T. B. Mallory and Dr. H. F. Hartwell showed a soft lobulated tumor about the size of a billiard ball. The pedicle was soft and broad. Microscopic examination showed a papillary growth with a complicated adenomatous structure. In some areas the tumor looked like a benign polyp, but in other areas there were atypical columnar epithelial cells in multiple layers, many cells containing mitotic figures. The appearance was consistent with that of a polyp which had become malignant. Four months later this patient died of cancer completely obstructing the œsophagus.

This case illustrates the simultaneous occurrence of a malignant adenomatous polyp and a carcinoma of the stomach. The carcinoma may have arisen from a similar malignant adenoma or may have arisen independently. The microscopic appearance of the polyp indicates that it probably would have become an adenocarcinoma.

J. Z., M. G. H. No. 274643, male, aged 50 years, entered the hospital February 13, 1926, complaining of vomiting attacks of 4 years' duration. The attacks occurred usually after eating or drinking anything cold. For about 2 years there had been almost constant gnawing pain around the umbilicus. Loss of strength had been marked for 2 months, and there had been a loss of 38 pounds in weight in the past 4 years. Gastro-intestinal X-ray films showed a mottled irregular filling defect involving the mid-portion of the stomach. The walls of the stomach in this region were rigid and peristalsis was absent. The findings were thought to be due to malignant disease. Operation was performed by Dr. Beth Vincent. The stomach contained a globular tumor, a little larger than a tennis ball, attached by a pedicle 3 centimeters in diameter at about the middle of the greater curvature of the stomach. The growth with its pedicle and a margin of apparently normal gastric mucous membrane was removed. Pathological examination by Dr. T. B. Mallory and Dr. H. F. Hartwell showed an area of stomach containing a soft, freely movable polypoid growth measuring 3 by 4 by 10 centimeters attached to the mucous surface by a broad base. Microscopic examination showed a branching papillary growth composed of closely set, irregular gland tubules, most of which were lined with normal epithelium, but some of which were formed by atypical cells in several layers with occasional mitotic figures. The growth was considered on the border line, although not invasive as yet, at least potentially malignant. It might well be classified as carcinoma *in situ* (Broders). This patient was seen recently in our gastro-intestinal clinic. It is about 7 years since his operation and he is entirely symptom free.

From the microscopic appearance of this polypoid tumor it seems very probable that had it not been completely removed it would eventually have undergone further changes and become definitely malignant.

J. J. O., M. G. H. No. 318371, male, aged 57 years, entered the hospital December 30, 1931, complaining of weakness, dyspnœa, and pallor of 1 year's duration. There had been occasional gnawing pains in the stomach, most marked 1 to 2 hours after meals, disappearing before the next meal. Food or soda for relief had not been tried. There had been a loss of about 20 pounds in weight in the past 2 years. Gastro-intestinal X-ray films showed a polypoid mass at the junction of the upper and middle thirds of the stomach. Gastric analysis showed no free hydrochloric acid. Operation was performed by Dr. Lincoln Davis on January 5, 1932. The stomach was found to contain a soft tumor the size of a small apple, at about the junction of the upper and middle third. Partial gastrectomy was performed. Three days later the patient died, necropsy showing general peritonitis and multiple pulmonary infarcts. Pathological examination of the stomach by Dr. J. I. Bradley and Dr. L. E. Hummel showed a broad based polypoid mass, 5.5 centimeters in diameter and 3.5 centimeters in thickness. The surface was irregular, necrotic, and composed of multiple small projecting polypoid masses of tissue. At one margin the growth was lower, slightly firm, and appeared to be more invasive. Six centimeters away was another smaller but similar polypoid mass 1.5 by 2 centimeters. Microscopic examination showed adenomatous polyp with marked atypical proliferation; in some areas the atypicality was so marked as to justify the diagnosis of adenocarcinoma.

The pathological description in this case seems to indicate adenocarcinoma arising from an adenomatous polyp.

J. F. L., M. G. H. No. 291246, male, aged 49 years, entered the hospital May 16, 1928, because of epigastric pain of 1½ years' duration, usually worse after meals. There had been no nausea or vomiting, but a loss of 20 pounds in weight in the past 3 weeks. Gastro-intestinal X-ray films showed large filling defects on the posterior wall of the stomach at the mid-portion and cardiac end; these were interpreted as due to inoperable carcinoma. Gastric analysis showed no free hydrochloric acid. The Hinton test was strongly positive on two occasions, but syphilis of the stomach was considered unlikely. A swinging temperature, which varied from 98 to 104 degrees during the month's stay in the hospital, was finally explained by a positive streptococcus viridans blood culture. On the thirty-third day in the hospital, after gradually becoming weaker and irrational, the patient died. Autopsy report by Dr. T. B. Mallory describes the stomach as follows: "Gross: Occupying the entire cardiac portion of the stomach but not involving the cardiac sphincter or the lower portion of the œsophagus is a large deeply ulcerated and perforated tumor mass with borders, in part polypoid and in part markedly nodulated. The crater measures nearly 5 centimeters in diameter and the total diameter of the growth is approximately 8 centimeters. Quite separate from this is a group of soft polypoid masses in the middle of the greater curvature about 8 centimeters from the pylorus. These show no induration and suggest benign polyps in appearance. Microscopic: Sections from the ulcerated tumor in the cardiac area show a fairly differentiated adenocarcinoma infiltrating the muscularis widely beyond the limits of mucosal involvement. Sections from the polypoid tumor show a much higher grade of differentiation. Many of the tubules approach the normal fairly closely, except for their great length. Near the base the tubules are less typical and show areas which are definitely carcinomatous with invasion of the muscularis. The inference that two carcinomata have developed from benign polyps is strongly suggested."

The autopsy findings seem to point to carcinomatous degeneration of two polypoid tumors.

B. R. P., M. G. H. No. 250549, male, aged 47 years, first entered the hospital August 29, 1916, complaining of

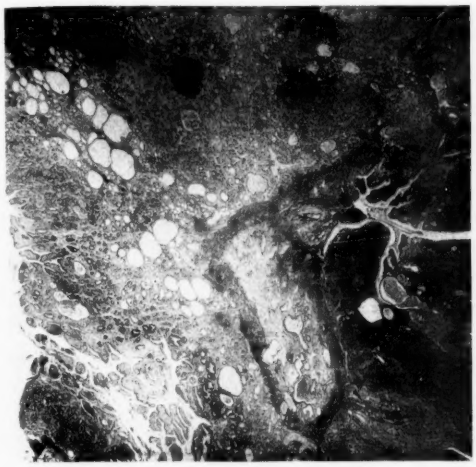

Fig. 1. Case B. R. P., 1917. Low power, showing simple adenomatous structure in some areas, malignant degeneration in others.

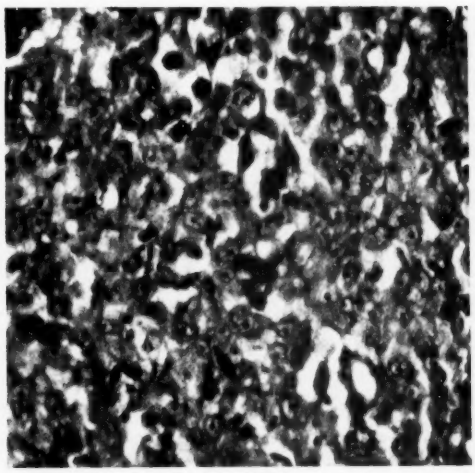

Fig. 2. Case B. R. P., 1917. High power, showing malignant structure of certain areas shown in Figure 1.

weakness, belching of gas, and abdominal discomfort after meals of 6 months' duration. There had been no nausea or vomiting. There had been a loss of about 15 pounds in weight. Physical examination was essentially negative, except for pallor and an indefinite mass in the epigastrium. Gastro-intestinal X-ray films showed a small 6 hour residue and a large mottled filling defect of the medial portion of the stomach. This mass inside the stomach was movable and was thought to be a polypoid tumor or a hairball. The red count was 3.4 million and the hæmoglobin 40 per cent on admission. The red cells showed moderate variation in size and considerable variation in shape, with marked achromia. The blood picture was considered to be that of secondary anæmia. Examination of the stool on admission showed a slightly positive guaiac reaction. Gastric analysis showed no free hydrochloric acid, and the guaiac reaction was very faintly positive on the stomach contents. A second gastro-intestinal X-ray examination a week after the first one confirmed the previous findings. Hairball of the stomach was considered unlikely, and the diagnosis was thought to be a polypoid tumor in the medial portion of the stomach. It was suspected that this might very well be malignant. Operation was advised but the patient refused to be operated upon, and was therefore discharged against advice with the diagnosis of question of carcinoma of the stomach and secondary anæmia.

Second admission, July 10, 1917. Since discharge 10 months before, the patient had had attacks of pain around the umbilicus, radiating to the back and at times followed by vomiting. Several times there had been moderate hæmatemesis. There had been a still further loss of weight and strength. The pain was almost immediately relieved by food or soda and sometimes by vomiting. The red count at this entry was 1.5 million and the hæmoglobin 20 per cent. Microscopic blood was present in the stools on two of six examinations. Gastro-intestinal X-ray examination was again performed and showed a large filling defect of the medial and lower part of the stomach, suggesting a large globular growth which was most extensive on the posterior wall and the greater curvature. There was no stasis. The X-ray department made a diagnosis of an extensive pathological process in the stomach, probably malignant. Operation was performed by Dr. C. A. Porter on July 19. When the abdomen was opened there was found no evidence of carcinoma. Palpation of the stomach showed five polypoid masses. The stomach was opened and a definite group of polypi enlarged to the size of a lemon was revealed. These growths were arising from two broad irregular pedicles on the posterior wall. The pedicles were clamped at the base and the tumors removed, following which the patient made an uneventful recovery. Pathological report by Dr. T. B. Mallory and Dr. H. F. Hartwell showed a very atypical type of polypoid tumor, showing in some areas the characteristics of benign adenoma and in other areas, chiefly near the surface of the tumor, many mitotic figures and the appearance of an adenocarcinoma. It was felt that this was a rapidly growing tumor, although there was no evidence of invasion of the submucosa (Figs. 1 and 2).

Third admission, June 27, 1922. Since his operation 5 years before the patient had been practically symptom free until 6 months before this entry, when he began to be troubled with gas, epigastric pain relieved by soda, and occasional vomiting. He had been able to work and had lost very little weight or strength. Examination of the stomach by X-ray showed an appearance suggestive of multiple polypoid masses. Gastric analysis again showed absence of free hydrochloric acid. No blood was found in the stools. There was a moderate secondary anæmia with a red count of 4.1 million and a hæmoglobin of 35 per cent. Operation was advised and again performed by Dr. C. A. Porter. Numerous polypoid growths were felt through the wall of the stomach, which was incised along the anterior surface. Several growths were clamped and excised down to the submucosa and the bare areas sutured with chromic catgut. Partial gastrectomy was considered at this time, but it was not felt that the patient's condition was good enough to justify it. Two days after operation the patient's temperature rose to 103 degrees with a rise in the pulse rate and respirations, and he died 5 days after

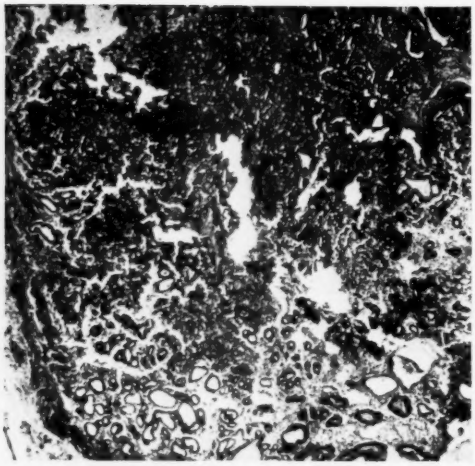

Fig. 3. Case B. R. P., 1922. Low power, showing similar appearance of this tumor to the one removed 5 years previously—some areas of simple adenomatous structure and other areas of malignant change.

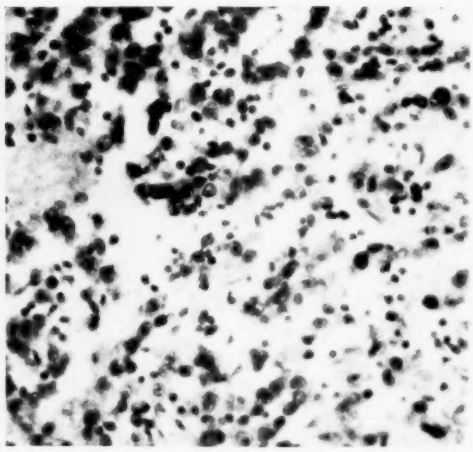

Fig. 4. Case B. R. P., 1922. High power, showing malignant structure of certain areas shown in Figure 3.

operation. Examination of the specimen removed from the stomach showed almost exactly the same type of tumor as had been removed 5 years previously, certain areas of which were adenomatous, other areas showing definite signs of adenocarcinoma (Figs. 3 and 4). Necropsy showed essential cause of death to be a general peritonitis.

We feel that this tumor began as an adenomatous polyp and later became definitely adenocarcinomatous. It might be classed as carcinoma *in situ*. The interval of 5 years' survival without evidence of metastases would indicate that the growth was actually not as malignant as it appeared histologically, and presumably means that local excision was sufficient to prevent recurrence. In all probability the second tumor was a new tumor of the same character, although we cannot be certain on this point. Judging from this experience, I believe that it would be wise in such tumors to do a subtotal gastrectomy, endeavoring thus to eliminate as much of the stomach as possible from which new tumors might arise.

A. F. B., M. G. H. No. 328513, male, aged 67 years, entered the hospital April 12, 1933, complaining of anorexia, heartburn, and epigastric distress of 6 weeks' duration. There had been no relation to intake of food and no nausea or vomiting. There had been a recent loss of about 5 pounds in weight. Physical examination was negative except for slight tenderness in the epigastrium and small bilateral indirect inguinal herniæ. Gastric analysis showed no free hydrochloric acid. Gastro-intestinal X-ray film showed a sharply defined oval filling defect, approximately 1 inch in length lying in the pyloric antrum about 1 inch from the pyloric valve. This was a constant defect and could not be displaced in any direction. It appeared to be attached to the greater curvature. As peristalsis passed over this area, it was felt the lesion was probably benign although an early carcinoma could not be excluded. Laparotomy was performed on April 17 by Dr. G. A. Leland under avertin-ether anæsthesia. A lesion was found almost exactly as described by the X-ray department, and a partial gastric resection with Billroth II anastomosis was done. Although the patient appeared at one time to be rallying from the operation, his temperature, pulse, and respirations all rose rapidly and he died the day after operation. Pathological report by Dr. T. B. Mallory showed an oblong polypoid mass, centered over the greater curvature, approximately 2 centimeters from the pylorus, and measuring 3 by 1.3 by 1.3 centimeters. It was attached by a definite pedicle 2 centimeters long and .5 centimeter thick. There was no suggestion of invasive growth at the base of the pedicle either on gross or on microscopic examination. Under the microscope, however, there were found a number of mitotic figures and there were areas of moderate atypical epithelial proliferation, which it was felt warranted a diagnosis of carcinoma *in situ*. A restricted postmortem examination failed to reveal the cause of death.

This tumor in certain areas had all the characteristics of a simple adenomatous polyp, and yet in other areas contained mitotic figures and epithelial cells in atypical proliferation, which makes it probable that it represents an adenomatous polyp undergoing malignant degeneration.

The following case is added to show what we feel the proper management of such cases:

W. J. M., M. G. H. No. 323250, male, aged 58 years, entered the hospital August 15, 1932, with a history of pain and bloating in the epigastrium of 2 months' duration. These symptoms would appear only after meals and would last for about 2 hours. There had been a feeling of weakness for 6 months and a loss of 30 pounds in weight in the past year. X-ray examination showed multiple pea

Fig. 5. Case W. J. M. Typical X-ray appearance of multiple gastric polyposis.

Fig. 6. Case W. J. M. Drawing of specimen removed at operation—multiple gastric polyposis.

sized polypoid masses in the greater curvature of the stomach (Fig. 5). Because there was also a 3 year history of sharp intermittent pain in the right flank, pathology in the kidney was suspected, and X-ray film showed a right renal calculus. It was then felt that possibly the stomach symptoms might be due wholly or partially to the kidney stone, and therefore it was considered advisable to operate upon the kidney. Right pyelolithotomy was performed by Dr. Sylvester B. Kelley. The patient's convalescence was uneventful.

Second admission, October 19, 1932. The patient had been completely relieved of genito-urinary symptoms and had regained his former strength. After a full meal he was still troubled with a feeling of distention and some epigastric pain. Re-examination of the stomach by X-ray showed the same multiple, small, rounded filling defects previously noted. The appearance was that of multiple polyposis, but malignant degeneration could not be positively ruled out. Gastric analysis showed a total acidity equal to 5 cubic centimeters of one-tenth normal sodium hydroxide 1 hour after 7 per cent alcohol and ½ hour after ergamine. The red count was 4.6 million, hæmoglobin 55 per cent, and leucocyte count 13,000; the smear showed marked achromia, some polychromatophilia, moderate anisocytosis, and poikilocytosis. Occult blood was present in the stools on two occasions. After very careful consideration, in view of his symptoms and the possibility of malignant degeneration, it was felt that operation was indicated. Accordingly on November 4 a subtotal gastrectomy was performed by Dr. A. W. Allen. Palpation of the stomach after the peritoneum was opened revealed multiple polypi throughout the medial four-fifths. An incision 3 inches long was made on the anterior wall of the stomach thus exposing an area with numerous polypi, varying from 1 millimeter to 1 centimeter in diameter. The mucosa in this region was literally studded with these polypi (Fig. 6). Three polyps were removed for biopsy and reported by frozen section to be adenomatous. The hand was then inserted into the stomach and it was found that a small area at the cardiac end seemed comparatively free of polypi. The opening in the stomach was closed, the pylorus cut across, and the stomach removed up to within 3 inches of the cardiac orifice. There still remained one polyp on the posterior wall of the unresected portion. This was removed and the stump cauterized. A long loop posterior Polya anastomosis with entero-enterostomy was performed. Pathological report showed over one hundred pedunculated, soft, granular polyps from 0.5 to 3 centimeters in diameter. A few isolated polyps were scattered about the central mass. The rugæ in the remainder of the stomach seemed larger than normal. None was frankly invading the muscularis or was definitely ulcerated. On microscopic examination the polyps were seen to be made up of a mass of normal glandular tissue in a fibrous tissue framework. There was slight inflammatory reaction about some of the larger polyps, but no evidence of malignancy was seen. The patient's convalescence was uneventful. Seven months after the operation he was seen in the gastro-intestinal clinic, at which time he was free of symptoms, gaining in weight and strength, and back at work.

Although pathologically the polyps in this instance showed no positive evidence of malignancy, they were multiple and adenomatous, gave definite symptoms and might have caused severe bleeding or become definitely malignant.

One further case is also included to indicate an unusual complication, viz., severe massive hæmorrhage from a small adenomatous polyp:

A. d'E., M. G. H. No. 326985, male, aged 50 years, entered the hospital February 1, 1933, because of severe hæmatemesis of 3 days' duration, accompanied by extreme weakness and pallor. For 5 years he had had attacks of upper abdominal pain with occasional vomiting, and at one time 4 years ago he vomited a considerable amount of blood. One year ago he began to complain of tingling and numbness in his hands and feet. Two months ago his epigastric pain became more severe than ever before and was not controlled by diet. Being a Nova Scotian fishing captain, his eating habits had always been very irregular. Physical examination showed a well developed and well nourished man, extremely pale and almost moribund. The tongue was very smooth. The pulse rate was 128 and of poor quality. Blood pressure, 125 systolic, 50 diastolic. Laboratory studies showed red count of 1.3 million; hæmoglobin, 35 per cent; white count, 4,000. Smear showed marked variation in size and shape of the red blood cells, which were well filled with hæmoglobin, occasional stippled cells, and polychromatophilia. The platelets were normal. Two normoblasts were seen. In view of the massive hæmorrhage, a diagnosis of bleeding peptic ulcer seemed most probable, but on account of the blood picture of pernicious anæmia, and the known association of gastric polyposis with pernicious anæmia, Dr. William B. Castle, of the Boston City Hospital, who happened to see this patient, suggested bleeding polyps as the diagnosis. Blood transfusion was done on the day of entry and again 2 days later, but, in spite of these, 5 days after entry the blood pressure suddenly dropped to 80, the pulse rose to 150, and the patient died. The day before death his temperature rose to 102.5 degrees and respirations to 28, and some râles were heard at the left base, suggesting an early bronchopneumonia in addition to the hæmorrhage. Autopsy confirmed Dr. Castle's diagnosis of hæmorrhagic polyp of the stomach and pernicious anæmia and showed also a left lower lobar pneumonia. The polyp measured 2 by 1 by 0.4 centimeter, was pedunculated, and located 4.5 centimeters below the cardia and 4.5 centimeters from the lesser curvature on the anterior wall of the stomach. There was no evidence grossly of invasion of the submucosa or of ulceration of the surface. Microscopically there was well marked gastritis with plasma cell infiltration throughout the entire stomach and the first portion of the duodenum. There was glandular atrophy, and no parietal cells were seen. The polyp consisted of a mass of large dilated glands, many of which were filled with polymorphonuclear leucocytes and red cells. At the free margin of the polyp the capillaries were dilated and filled with blood. There was no evidence of malignancy. Pathological diagnosis: bleeding adenomatous polyp.

Although such severe bleeding with hæmatemesis is rare in polyps of the stomach, moderate bleeding with gross or occult blood in the stools is by no means rare and should be seriously considered as an indication for surgery.

EVALUATION

Symptomatology. There is nothing pathognomonic in the history of these patients. Loss of weight and strength, anorexia, epigastric pain, nausea, and vomiting are the most frequent symptoms, but none is invariable. Moderate bleeding by rectum occurs in about 25 per cent of the cases. Fatal bleeding with hæmatemesis occurred in one case of this group, but is unusual.

Laboratory findings. Gastric analysis is likely to show a very low acidity or an achlorhydria. The blood picture frequently is that of a primary anæmia. In this series of 17 cases primary anæmia was diagnosed five times.

X-ray examination. The X-ray study is often the most helpful procedure in establishing the diagnosis, but even the most expert roentgenologist is frequently unable to tell whether a filling defect is due to carcinoma or to a benign tumor.

Treatment. Surgery is usually to be advised because of the possibility of hæmorrhage or of malignant degeneration. Each case, however, must be decided on its own merits; operative risk, size of lesion, and severity of symptoms should all be carefully considered.

CONCLUSIONS

In a series of 17 cases of gastric polypi giving fairly severe symptoms, there was microscopic evidence of potential malignancy in 7 cases, or an incidence of 41.2 per cent.

In view of this high incidence of malignancy and the tendency to moderate or even very severe hæmorrhage, radical surgery must be seriously considered in all gastric polyps.

The authors wish to express their thanks to Dr. T. B. Mallory for reviewing the pathology in these cases.

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EPIPHYSEAL SEPARATION OF THE LONG BONES

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THE frequency of the occurrence of epiphyseal separations makes this subject one of considerable importance to the surgeon dealing with fractures in childhood and adolescence. The accepted teachings lead one to believe that accurate anatomical replacement is desirable to avoid the possibility of deformity caused by cessation of bone growth resulting from premature ossification of the epiphyseal cartilage.

This study of epiphyseal separation of the long bones is based on an analysis of 110 cases from the records of the Surgical Outpatient Department and Surgical Service C of the Hospital of the University of Pennsylvania. The cases are consecutive and have been followed over a period of 1 to 7 years so that the end-results can be well determined.

It is our purpose to show the results obtained in this series and to point out (1) that premature ossification of the epiphyseal cartilage occurs comparatively rarely following epiphyseal separations, (2) that the degree of reduction is not a factor in premature ossification of the epiphyseal cartilage (Figs. 1, 2, and 3), and (3) that the extent of the epiphyseal injury cannot always be determined at the time of the original injury.

The functions of the epiphyses are, first, to develop the length of bones; second, to serve in the formation of joints; and third, to serve as attachments for ligaments and tendons. They are intimately attached to the shaft by dense periosteum but have a sort of existence independent of the rest of the bone. Their blood supply is obtained mostly from the periosteal network of arteries which perforate the thin external layer of compact tissue to be distributed throughout the spongy cancellous tissue within. Only one or two small vessels pass from the diaphysis to the epiphysis through the conjugal cartilage. This accounts for the comparatively infrequent occurrence of necrosis of the epiphysis in traumatic separations, even when there is wide displacement (Poland).

Growth of bone takes place from the diaphyseal surface of the epiphyseal cartilage. Ossification is accompanied by a growth of cartilage on the epiphyseal side of the disc until the cartilage finally ossifies. The age at which the epiphyses become ossified, and the age at which they join the shaft of the bone varies quite widely in the statements of the numerous authorities on the subject. The epiphyses ossify first, and bone growth is therefore least at the end of the bone toward which the nutrient artery is directed. Since these arteries run toward the elbows and away from the knees, it would follow that the epiphyses most concerned with bone growth in the upper extremity are the proximal epiphysis of the humerus and the lower epiphyses of the radius and ulna. In the lower extremity, however, the lower epiphysis of the femur and the upper epiphysis of the tibia are the most active. The fibula, however, is an exception to this rule, since its lower epiphysis is the last to ossify.

Epiphyseal separations are described as fractures in which the line of fracture lies wholly or in part in the epiphyseal line. They are often associated with a fracture at the end of the diaphysis, and usually the epiphyseal cartilage is carried with the epiphysis in its displacement. When the separation is complete the periosteum is frequently torn from the diaphysis for a considerable distance.

Epiphyseal separations occur with the least trauma in the first decade of life, and at this period their reduction is most easily performed. As the child grows older, the epiphyseal line becomes more irregular, so that greater trauma is necessary to produce separation and more difficulty is experienced in their reduction. The cause of these injuries is, in most cases, trauma producing a strain of the ligaments about a joint. The epiphyseal line, being the weakest point, gives way. Of 293 injuries in the region of joints in patients within the epiphyseal age, separation occurred in 114 cases, an incidence of 38.9 per cent. The site of separation was most often at the lower radial and lower humeral epiphyses.

The subjective symptoms are frequently not marked, especially in separations of bones of the upper extremities. In many cases the pain is so slight or short lived that the injury is overlooked and regarded as a sprain until after 24 hours or more, when sufficient soreness appears as the member is used to recall the injury to the patient's attention. Swelling and ecchymosis may be very slight, especially when the separation is only partial. Many of the objective signs on which the diagnosis of fracture is based may be absent or difficult to elicit. Crepitus, when present, is soft or muffled and is frequently described as being like the sensation of wet snow being

Fig. 1. Fig. 2. Fig. 3.

Fig. 1. Minerva F., 13 years. Fell on left forearm April 16, 1928. April 18, 1928, roentgenogram shows adolescent fracture of the radius and epiphyseal separation of the lower ulna with posterior displacement and fracture of the posterior aspect of the ulnar diaphysis.

Fig. 2. Same patient as in Figure 1, May 9, 1928, after reduction, showing good reposition of left ulnar epiphysis. Right wrist is shown for comparison.

Fig. 3. Same patient as Figure 1, October 4, 1930. Note complete ossification of the left ulnar epiphysis. Right wrist for comparison.

crunched in the hand. It may easily be mistaken for the soft crepitus sometimes occurring in joints. Preternatural mobility is usually hard to obtain due to the difficulty of grasping the small fragments and to the fact that injury occurs so close to joints where mobility is normally present.

Roentgen-ray diagnosis is also not without difficulty. Injuries which occur before there is an ossified epiphyseal center cannot be demonstrated roentgenologically. Even those which take place after a well formed epiphysis is present are often hard to show unless there is a displacement or an accompanying splitting off of the diaphysial end of the bone. As a consequence, many roentgenograms of bones in the region of joints of patients in the epiphyseal age are reported as "negative, epiphyseal separation not excluded."

The diagnosis of epiphyseal separation then is not difficult when there is displacement of the epiphysis with deformity in the region of the epiphyseal line, or signs demonstrable by roentgenogram. Many injuries in childhood and youth, however, which show none of these signs, are undoubtedly epiphyseal separations of some degree and in these cases the diagnosis must be made clinically on the basis of the history of an injury, persistent point pressure tenderness at the site of the epiphyseal line, and usually some disability in motion of the adjacent joint. These patients deserve the same treatment as those in whom roentgen diagnosis is made, and in many cases a roentgen-ray diagnosis is possible at a later date when signs of calcifying callus make their appearance (Figs. 4, 5, 6, 7, 8).

Repair takes place following epiphyseal separation in much the same way as it does in the osseous portion of bones. Callus formation is, as a rule, less than that observed in fractures. Union practically always takes place. Accurate anatomical reduction of the fragments is to be desired in these injuries because (1) disabilities may result from deformity of the adjacent joint, especially in epiphyseal injuries about the elbow joint, or (2) there may otherwise be a disturbance in the growth of the bone. Authorities have taught that unless accurate reposition of the epiphysis is accomplished, bone growth may be delayed or halted due to premature ossification of the epiphyseal cartilage. This result is infrequent in our experience (Figs. 9, 10, 11, 12).

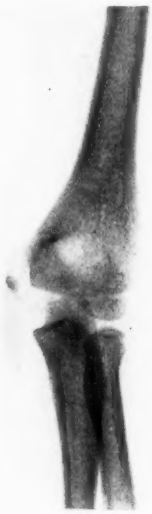

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 4. Norman G., aged 9 years, fell on left elbow. Roentgen-ray diagnosis: possible epiphyseal separation of the internal epicondyle June 7, 1930.

Fig. 5. Same patient. Five weeks later calcification about the detached epiphysis makes diagnosis certain.

Fig. 6. John McD., aged 13 years. Fell on right forearm; diagnosis, buckle fracture of radius, suprastyloid level, July 27, 1929.

Fig. 7. Same patient as Figure 6, August 26, 1929. Four weeks later patient fell from bicycle on right forearm. Secondary fracture of the radius. Epiphyseal displacement of the lower ulna now apparent. The callus formation at the epiphyseal line indicates that the ulnar epiphysis was displaced at the time of the first injury.

Fig. 8. James D., aged 8 years. Two years before had reduction of posterior dislocation of elbow and separation of the internal epicondyle. He now shows fragmentation of the olecranon with separation of both epicondyles. A normal compound center here must be borne in mind at the olecranon.

A study has been made here of 110 epiphyseal separations, all of which have had positive roentgen diagnoses and are more than one year old. Follow-up results were obtained in 60 cases.

These cases were divided as in Table I.

EPIPHYSEAL SEPARATION OF THE LOWER RADIUS

During the growing period, epiphyseal separations occur almost as frequently as do fractures in injuries in the region of the wrist. Table II gives the incidence of 141 such injuries occurring in the epiphyseal age taken from the records of our Department of Roentgenology.

The lower radial epiphysis is separated more frequently than any other in the body. In this series are 48 cases, nearly as many as all the other types collectively. These separations occur most commonly between the ages of 8 and 18 and are almost always due to indirect trauma: a fall on the hand (38 cases) or cranking a car (7 cases). The symptoms may be very slight when there is little displacement. A localized, sharply defined line of tenderness over the epiphyseal line or pain

TABLE I.—EPIPHYSEAL SEPARATIONS—INCIDENCE ACCORDING TO BONES

Radius		
Upper epiphysis		1
Lower epiphysis		48
Humerus		
Head		2
Lower epiphysis	3	
External epicondyle	8	
Internal epicondyle	24	36
Both epicondyles	1	
Ulna		
Lower epiphysis		0
Olecranon		1
Femur		
Head		2
Lower epiphysis		3
Lesser trochanter		2
Tibia		
Lower epiphysis		4
Fibula		
Lower epiphysis		2

Fig. 9.

Fig. 10.

Fig. 11.

Fig. 12.

Fig. 9. David W., aged 8 years. Fell on outstretched hands. Separation of lower radial epiphysis of both arms, first seen 5 days after the separation had occurred. Attempts at fluoroscopic reduction did not improve the position. Roentgenogram shows position of epiphysis June 9, 1926, right arm.

Fig. 10. Same patient as in Figure 9. Right arm, November 10, 1932. Epiphyseal development apparently normal except for a separation of the ulnar styloid.

Fig. 11. Same patient as in Figure 9. Left arm, June 9, 1926.

Fig. 12. Same arm, November 10, 1932.

on movement of the wrist may be the only signs present in reduced or slightly displaced separations. When displacement does occur, it is practically always posteriorly, and it produces a deformity which is lower and less marked than is found in the suprastyloid or Colles' fracture in adults. Separations occurring in patients in the teens are frequently associated with a wedge-shaped fracture of the posterior edge of the diaphysis, seen most easily in the lateral roentgenogram; or a fracture of the ulna, especially of the styloid (Figs. 13, 14, 15, 16).

EPIPHYSEAL SEPARATION OF THE LOWER RADIUS AND ASSOCIATED INJURIES

So frequently is a fracture of the ulnar styloid an accompanying injury that any patient in the epiphyseal age showing the injury should be suspected of having an epiphyseal separation of the radius whether or not it is shown in the roentgenogram (Fig. 17). In the diagnosis, tenderness over the ulnar styloid should lead one to think of the possibility of separation of the lower radial epiphysis in an individual under 20 years of age, the approximate time when this epiphysis unites with the shaft.

When displacement is present, early fluoroscopic reduction is the recommended treatment. With the hand in palmar flexion, dorsal pressure over the epiphysis usually will accomplish replacement and once reduced there is little tendency to displacement if the wrist is held in acute palmar flexion. Light plaster splints molded to the part with gauze bandages maintain the reduction. When there is little or slight displacement, a single anterior plaster splint gives sufficient immobilization and permits use of the fingers during the splint wearing period. Early active and passive motion under supervision is encouraged, as in all fractures near joints. Calcification is usually sufficient at the end of 3 weeks to permit removal of the splints with limited function in a sling for another week.

Twenty-eight of the 48 patients have returned for follow-up examination from 2 to 7 years after their injuries. All of those examined have normally functioning arms, without any demonstrable disturbance of growth or any evidence of deformity except a slight thickening of the wrist.

TABLE II.—INCIDENCE

	Cases	Per cent
Fracture radius alone	36	
Fracture radius and ulna	33	
Fracture ulnar styloid	7	
	76	54
Epiphyseal separation lower radius plus fracture of diaphysis or ulnar styloid	33	
Epiphysis separation lower ulna plus fracture radius	1	
Epiphysis separation lower radius	31	
	65	46

TABLE III.—ASSOCIATED INJURIES

	Cases
Epiphyseal separation lower radius alone	16
Epiphyseal separation plus fracture of diaphysis	13
Epiphyseal separation plus fracture of diaphysis and ulnar styloid	8
Epiphyseal separation plus fracture ulnar styloid	8
Epiphyseal separation both radius and ulna	3

Fig. 13. Fig. 14. Fig. 15. Fig. 16.

Fig. 13. W. K., aged 11 years. Reduced epiphyseal separation lower radius.

Fig. 14. Vince I., aged 11 years. Reduced epiphyseal separation lower radius with slight fracture of the diaphysis.

Fig. 15. Charles B., aged 10 years. Reduced epiphyseal separation lower radius with wedge-shaped fracture of the posterior aspect of the diaphysis.

Fig. 17.

Fig. 16. Thomas C., aged 11 years. Posterior displacement of the lower radial epiphysis with wedge-shaped fracture of the diaphysis.

Fig. 17. Margaret C., aged 11 years. Marked posterior displacement of the lower radius with fracture of the tip of the ulnar styloid are demonstrated in the roentgenogram.

Six of the patients followed are reported by the roentgenologist to have had incomplete reduction of the epiphysis, but the results in these cases were as good as those in which the reduction was perfect (Figs. 18, 19; see also Figs. 9, 10, 11, 12). These patients varied in age from 8 to 14 years and most of them came for treatment some time (3 to 14 days) after their injuries. Unsuccessful attempts at reduction were made in most cases. The results obtained indicate that energetic efforts to reduce the displaced epiphysis in late cases are useless and unnecessary in the younger age groups. Certainly open reduction with replacement of the epiphysis is rarely indicated. The above would seem to indicate that conservatism should be the rule in dealing with displacements of the lower radial epiphysis.

SEPARATION OF THE LOWER EPIPHYSIS OF THE ULNA

This epiphysis is formed about the fifth or sixth year and joins the shaft at about the twentieth year. It is firmly united to the radius by the anterior and posterior inferior radio-ulnar ligaments and articulates indirectly with the carpus through the triangular fibrocartilage attached to the base of the styloid. This is the epiphysis which last unites to the shaft and from which comes most of the longitudinal growth of the ulna.

This separation occurred 9 times in the series. All of the patients but one were between the ages of 13 and 16 years. In each case there was a history of indirect trauma: falls on the hand in 5 cases and back-fire in cranking automobiles in 4 cases.

Epiphyseal separation of the lower ulna rarely if ever occurs uncomplicated. Because of the indirect relationship which the ulna bears to the hand, the brunt of the force is transmitted to the lower radius and indirectly to the ulnar epiphysis by the strong radio-ulnar ligaments. As a consequence, separation of the lower ulnar epiphysis is almost invariably associated with a fracture or epiphyseal separation of the lower radius (Fig. 20, see also Figs. 5 and 6). Posterior displacement of the epiphysis is the rule.

Fluoroscopic reduction of the epiphyseal separation and of the accompanying injury to the radius is the treatment of choice. Usually slight palmar flexion is the position which most easily maintains reduction, and light anterior and posterior plaster splints molded to the part give the most comfortable immobilization. Active and passive motion, with the wrist supported in the grasp of the surgeon's hand, is begun after the

Fig. 18. Fig. 19. Fig. 20.

Fig. 18. Eleanor, aged 10 years. Came for treatment 3 weeks after fall on the hand. Roentgenogram October 16, 1928, showing marked posterior displacement of the lower radial epiphysis with wedge fracture of the adjacent diaphysis. Attempts at reduction failed to improve the position.

Fig. 19. Same patient as in Figure 18. Roentgenogram November 12, 1932, 4 years later. Practically normal epiphyseal development. Separation of the ulnar styloid.

Fig. 20. Harry G., aged 16 years. Injured cranking car. Separation of epiphysis of both radius and ulna at wrist with fracture of the ulnar epiphysis. This patient has a perfect anatomical and functional result 7 years after injury.

first week and the splints are removed in 3 to 4 weeks.

Follow-up examinations have been made in 5 cases. All of these have perfect functional results, and in 1 case only was there any anatomical deformity. This patient, who had also a fracture of the posterior lip, of the diaphysis, and a suprastyloid fracture of the radius, was reported by the roentgenologist as having had a perfect reduction. She now has a very slight ulnar deviation of the hand, which is shown by roentgenogram to be due to premature ossification of the epiphyseal cartilage (Fig. 1). In view of the fact that growth of the ulna takes place mostly from the lower epiphysis, the very slight amount of deformity present is noteworthy. The number of cases of this separation of the epiphysis is not sufficient for us to generalize as to the effect upon subsequent development.

SEPARATION OF THE UPPER EPIPHYSIS OF THE RADIUS

The nucleus for the head of the radius usually becomes apparent in the roentgenogram during the fifth year. Ossification occurs from several centers which join together and unite with the shaft during the seventeenth year. The epiphysis forms only the proximal half of the radial head and is entirely intra-articular. It is surrounded by the firm orbicular ligament. Separation of this epiphysis is rare except in association with posterior dislocation of the elbow.

The single case in this series was sustained by a fall on the outstretched hand. The chief deformity was due to a posterior dislocation of the elbow, the epiphyseal displacement of the radial head was reduced with the reduction of the dislocation (Fig. 21).

The treatment of this injury varies somewhat with the conditions found. If the entire epiphysis is displaced and can be reduced, immobilization in the Jones position for 3 to 4 weeks is usually sufficient. If the epiphysis is fractured or so displaced that closed reduction is impossible, operation with removal or replacement of the epiphysis is indicated.

TABLE IV.—INJURIES ASSOCIATED WITH SEPARATION OF LOWER ULNAR EPIPHYSIS

	Cases
Suprastyloid fracture radius	1
Fracture diaphysis ulna and radius fracture above suprastyloid level	2
Radius fracture above suprastyloid level	4
Epiphyseal separation lower radius	2

SEPARATION OF THE OLECRANON EPIPHYSIS

Separation of the upper epiphysis of the ulna occurs very infrequently. This epiphysis, which appears during the ninth or tenth year, includes the upper part of the olecranon and lies within the insertion of the triceps. Between the ages of 14 and 16, when union with the olecranon occurs the epiphyseal line is very narrow and may be taken for fracture. Between the fifth and ninth years, two centers of ossification may be seen, but fusion usually takes place during the ninth year

The single case in our series was a boy of 13 years who fell on his elbow while skating. Separation of the olecranon and fracture of the epiphysis resulted. He made a good recovery after fixation on an internal right angled splint (Fig. 22).

EPIPHYSEAL SEPARATIONS AT THE LOWER EXTREMITY OF THE HUMERUS

In order to understand lower humeral epiphyseal separation it is necessary to be familiar with the nature of the epiphyseal development in this region. In one stria of cartilage at the lower humerus, ossifying centers are developed for the capitellum, the internal epicondyle, the trochlea, and the external epicondyle, respectively (Fig. 23). During the thirteenth year the three external centers unite to form the lower humeral epiphysis which fuses with the shaft in the sixteenth to seventeenth year. The internal epicondylar epiphysis remains separate and unites with the shaft during the nineteenth year. This means that after the thirteenth year, a separation of the lower humeral epiphysis may leave intact that of the internal epicondyle.

The line of the epiphysis is transverse at birth, but in early youth, the age at which most separations occur, it extends obliquely downward and inward from a point just above the external condyle to one below the internal epicondyle. This obliquity of the epiphyseal line may account in part for the frequent lateral displacement of the epiphysis and for the difficulty in maintaining accurate reduction. This difficulty is somewhat compensated for by the fact that the joint capsule is attached above the epiphyseal line, so as to enclose all but the internal epicondyle. Epiphyseal separations therefore enter the elbow joint and consequently cause much intra-articular swelling, but no great displacement of the fragments unless accompanied by a severe tear of the capsular ligaments.

Up to the age of 10, about one-fifth of the growth of the humerus is believed to come from the lower epiphysis, but after this time there is little growth from the epiphysis; hence its separation has little effect on the length of the bone, but because of the large part it plays in the formation of the elbow joint, accurate reduction is important if normal function is to be preserved (Figs. 24, 25).

Injuries about the elbow in childhood and youth result in epiphyseal separations somewhat less frequently than in fractures. In 93 patients within the epiphyseal age there were 37 (39.8%) in which injuries resulted in epiphyseal separations (Table V).

Fig. 21, left. H. Y., aged 10 years. Separation of upper epiphysis of radius with fracture of the diaphysis.

Fig. 22. David A., aged 13 years. Separation of the olecranon epiphysis with fracture of the epiphysis resulting from fall on the elbow. Here the existence of multiple ossification centers must be remembered.

TABLE V.—INJURIES ABOUT THE ELBOW JOINT IN EPIPHYSEAL AGE—93 CASES FROM THE DEPARTMENT OF ROENTGENOLOGY

	Cases
Fracture lower humerus	36
Fracture olecranon or coronoid	6
Fracture of head of neck of radius	11
Dislocation of elbow	2
Dislocation and fracture	1
	56
Epiphyseal separation with fracture or dislocation	7
Epiphyseal separation of humerus	
Internal epicondyle	17
External condyle	8
Both condyles	3
Epiphyseal separation of ulna	
Olecranon	2
	37

In this series there were 36 cases of separation of the epiphysis of the lower humerus divided as follows:

TABLE VI.—SEPARATION OF EPIPHYSIS OF LOWER HUMERUS

	Cases
Lower humeral	3
External epicondyle	4 } 8
External epicondyle plus fracture of diaphysis	4 }
Internal epicondyle	24
Both epicondyles	1
	36

Fig. 23. Epiphyseal development of the lower humerus in a child 14 years old. (From Poland's *Traumatic Separation of the Epiphyses.*)

Fig. 24. Fig. 25. Fig. 26.

Fig. 24. Edith G., aged 11 years. Injured right elbow in sledding accident. Diagnosis, February 4, 1928, epiphyseal separation of the internal condyle, with slight displacement of the fragment.

Fig. 25. Same patient as in Figure 24, 2 years, 8 months later. Evidently there was a displacement of the trochlear epiphysis at the original injury. The trochlea and internal condyle have united in mesial displacement.

Fig. 26. Raymond L., aged 12 years. Fell striking left elbow. Separation of epiphysis of external epicondyle.

Separations of the lower humeral epiphysis, including the external condyle (Figs. 26, 27) may occur at any time from birth to 15 or 16 years of age. The ages in these 11 cases fell between 2 and 13. They may be caused by either direct or indirect trauma and produce much the same symptoms as do supracondylar fractures. There is usually pain and tenderness on use of the elbow and on pressure over the external condyle. Swelling is often considerable, due in part to an effusion into the elbow joint because the joint capsule extends above the epiphyseal line. In about one-half of the cases, the patients were not brought for treatment until 2 days or more after the injury. Pain was not a prominent symptom, unless joint motion was attempted, and the outstanding symptom was the persisting swelling.

The usual displacement is posterior and/or lateral and in most cases the periosteum is carried back with the epiphyseal fragment. This is probably the cause of the later thickening of the lower end of the bone.

The diagnosis must be made from dislocation of the elbow and supracondylar fracture. The points in this diagnosis may be shown in table form (Table VII).

TABLE VII

Epiphyseal separation	Dislocation	Supracondylar fracture
Motion of forearm	Immobility of forearm	Motion of forearm
Muffled crepitus	No crepitus	Crepitus
Olecranon-epicondyle line normal	Olecranon-epicondylar line abnormal	Olecranon-epicondylar line normal
Acromio-epicondylar line shortened	Acromio-epicondylar line normal	Acromio-epicondylar line shortened
Deformity slightly above elbow joint	Deformity at elbow joint	Deformity above elbow joint

Treatment in cases without displacement consisted in fixation in the Jones position. Where there was displacement, fluoroscopic reduction was practiced with the application usually of the Eliason plaster dressing, with the arm held in the lateral hyperflexed position for 10 days. Passive motion was given early, followed by baking and massage after the third week.

Follow-up results were obtained in 9 of the 11 cases. Five of these were without deformity and had perfect function of the elbow. Four showed some limitation of flexion on extension, and in one case there was marked deformity present.

SEPARATION OF THE INTERNAL EPICONDYLAR EPIPHYSIS OF THE HUMERUS

The internal epicondylar epiphysis is formed from a separate ossification center which appears at about the fifth year in the cartilaginous plate over the end of the humerus. The development and downward growth of the diaphysis displaces the epiphysis internally so that the internal epicondyle becomes separated from the rest of the lower epiphysis and at the twelfth or thirteenth year is a distinct, detached epiphyseal particle not communicating with the joint. It unites to the shaft in the twentieth to the twenty-second year. It serves as the origin of many of the flexor muscles of the forearm, viz., the flexor carpi radialis, the flexor carpi ulnaris, the flexor sublimus digitorum, the palmaris longus, and part

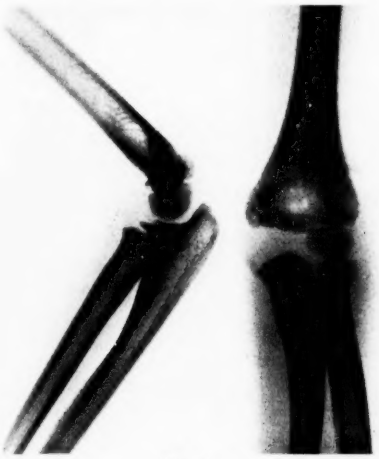

Fig. 27.

Fig. 28.

Fig. 29.

Fig. 27. Manuel Y., aged 9 years. Fell from tree. Pain and tenderness at epiphyseal line. Reduced epiphyseal separation lower humerus.

Fig. 28. Adele T., aged 8 years. Fell on elbow. Epiphyseal separation of internal epicondyle.

Fig. 29. Vincent S., aged 14 years. Fell on arm. Roentgenogram discloses epiphyseal separation of head of humerus.

of the pronator radii teres. This muscular attachment probably accounts for the downward displacement usually found in the separation of this epiphysis (Fig. 28).

One other anatomical point should be emphasized in connection with this separation. The ulnar nerve passes around this epiphysis in a canal, the roof of which is formed by a fibrous band passing from the epicondyle to the inner side of the olecranon. This relation of the nerve to the epicondyle accounts for the not uncommon involvement of this nerve in epiphyseal separation.

Separation of the internal epicondyle occurred more frequently than those of the external epicondyle in this series—24 cases. Direct trauma was the cause in 16 of the patients. All but a few patients were boys between the ages of 8 and 12. As is the case with slight separation of the lower humeral epiphysis, the symptoms at the time of injury are often mistaken for those of a sprain, but may usually be diagnosed on the basis of pain and sharp tenderness over the condyle, swelling on the inner side of the elbow and pain on motion, especially rotation of the arm.

The separation was complicated by a dislocation of the elbow in 2 cases.

The treatment consisted of fixation in the Jones position or on an internal right angle splint for two weeks, followed by semi-fixation in a sling and physiotherapy.

Follow up results were obtained in 15 cases. In 12 cases there was a normal anatomical and functional result. In 3 patients, there was a limitation of motion at the elbow and one case showed some deformity by roentgenogram.

An interesting feature, and one which has not been well emphasized in the literature, is that ulnar nerve injury may follow separation of the epiphysis of the internal epicondyle. This complication occurred in 5 cases and was characterized by a numbness or loss of sensation in the ulnar distribution in the hand. The symptoms disappeared under conservative treatment.

INJURIES ABOUT THE SHOULDER JOINT

Injuries about the shoulder joint very occasionally produce epiphyseal separations. In this series, there were 2 cases. The upper humeral epiphysis forms during the fifth year from the coalescence of the nuclei of the lesser and greater tuberosities, and that of the head. It unites with the shaft during the nineteenth and twentieth year. The epiphysis is concave and rests on the end of the diaphysis like an inverted cup. It is for this reason difficult to displace, and separations, when they do occur, are usually incomplete. Growth of the humerus takes place largely from the upper epiphysis, hence early and accurate reduction is recommended.

The two patients, 11 and 15 years of age, fall within the period when this separation is most

Fig. 30.

Fig. 31.

Fig. 32.

Fig. 30. Margaret F., aged 11 years. Limp without pain in left leg in July, 1926. Limp persisted and on August 26, 1926, this roentgenogram was made and reported "negative." Note that the neck of the femur has begun to slip upward and that there is rarefaction at the epiphyseal line.

Fig. 31. Same patient as in Figure 30, December, 1926. Two days before, patient slipped and fell on an icy slope. Typical appearance of slipping epiphysis of head of femur.

Fig. 32. Same patient as in Figure 30. April, 1929. Appearance of femur 2 years after reduction. Normal functional result.

likely to occur, and resulted from accidents in which the arm was forcibly abducted in complete external rotation (Fig. 29).

The symptoms were characteristic of this separation: pain and swelling in the region of the shoulder joint and deformity in which the rotundity of the shoulder is preserved with a depression just below the tip, but not as far down as that noted in fracture of the surgical neck. The patient usually holds the affected extremity in his well hand. The soft crepitus said to be characteristic of epiphyseal separations can be better palpated in this instance than in any other. Roentgen-ray diagnosis is difficult before the fifth year when the three ossifying centers coalesce to form the upper epiphysis proper.

Both cases of this series were easily reduced under fluoroscopic control by traction with abduction and external rotation of the arm and counter pressure over the shoulder. Once reduced, there is little tendency to recurrence.

The dressing consisted of a shoulder cap, axillary pad, wrist sling, and body swathe, maintained for 3 to 4 weeks. The anatomical and functional results were good in both cases.

TABLE VIII.—INJURIES ABOUT THE UPPER HUMERUS IN EPIPHYSEAL AGE. 26 CASES FROM THE DEPARTMENT OF ROENTGENOLOGY

	Cases
Fracture surgical neck	18
Fracture below surgical neck	3
Dislocation with fracture of greater tuberosity	2
Epiphyseal separation head of humerus	3
	26

Separation of the epiphyses of the lower extremities occurs much less frequently than in the upper extremity—only 12 cases of the former in our series as compared with 96 of the latter.

SEPARATION OF THE CAPITAL EPIPHYSIS OF THE FEMUR

It will be seen that epiphyseal separation occurred more frequently during the epiphyseal age than did fracture in injuries around the hip joint (Table IX). The epiphyseal head of the femur develops from an ossifying center which appears during the latter half of the first year of life. As the shaft grows upward to form the neck of the bone, this center becomes separated from that of the greater trochanter. The epiphysis rapidly ossifies, so that at an early age it may be seen in roentgenograms as a bony cap separated from the neck by a thin epiphyseal line. It unites with the shaft at about the twentieth year. The capital epiphysis lies completely within the synovial membrane of the hip joint.

Although the traumatic separation of this epiphysis may occur due to direct violence, the

TABLE IX.—INJURIES ABOUT THE HIP JOINT IN EPIPHYSEAL AGE

Fracture through base of neck and greater trochanter	1
Fracture upper ⅓ femur	4
	5
Epiphyseal separation head of femur	6
Epiphyseal separation lesser trochanter	2
	8

incidence of such injuries is slight. In childhood, a fall backward with the leg fixed, as when the child is held in arms, is said to cause a separation of the epiphysis by extreme extension. This is held by some authors to be the most common injury to the hip in childhood.

The common type of epiphyseal separation of the femoral head is that which occurs in adolescence. It rarely is seen below the age of 10 years. The cause of the separation is not definitely established. Trauma, although apparently an etiological factor, does not entirely explain the lesion. Key points out that if the degree of trauma encountered in these cases were sufficient to cause epiphyseal separation in the normal adolescent, then epiphyseal separation would be almost universal because the average adolescent suffers a number of such injuries yearly. Because many of the patients with this lesion are of the fat, overgrown type, Wilson and others believe that an endocrine unbalance, probably a hypofunction of the pituitary, plays an etiologic rôle. Balensweig (1) and Buchman (3) look upon the condition as one of a low grade osteochondritis, which may be initiated or accentuated by trauma. This theory is supported by the roentgen findings in these cases. Key suggests that during the period of rapid adolescent growth, there may be a stretching, thinning, and consequent weakening of the periosteum spanning the epiphyseal line, thus permitting easy separation of the capital epiphysis on slight trauma.

The names given to this lesion, "slipping epiphysis," epiphyseal coxa vara, femoral osteochondritis of adolescence, and so forth, are proof of the uncertainty of the etiology (Figs. 30, 31, 32).

Separation of the capital epiphysis of the femur occurred twice in this series and both of these were probably cases of so called slipping epiphysis or osteochondritis juvenalis femoris. Both patients were in the usual age period, 11 and 13 years, and the history was typical of this disease as it is described. The patients walked with a limp and noted pain in the region of the left hip for a month or more, when, while walking on level ground, they suddenly fell backward. They were unable to walk or to move the affected leg and the foot assumed the everted position with the leg extended, so that they were mistaken for fractures of the neck of the femur. The treatment in both of these cases consisted of reduction of the separation under fluoroscopic control. With the limb in extreme abduction, a Whitman cast was applied and allowed to remain in place for 8 to 12 weeks. Gradual weight bearing was then encouraged. Both of these patients have good functional results. In one there is a premature ossification of the epiphyseal line with about one inch shortening 6 years after his injury.

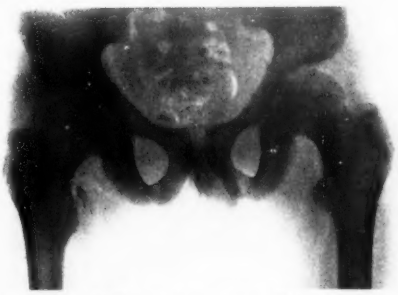

Fig. 33. Joseph H., aged 13 years. Fell while running; unable to walk. Epiphyseal separation of right lesser trochanter. One year later an identical lesion occurred on left side.

SEPARATION OF THE LESSER TROCHANTER OF THE FEMUR

The lesser trochanter of the femur appears in the roentgenogram at about the thirteenth year and usually joins the shaft during the eighteenth year. It is rarely separated by direct violence, but there are a few cases on record (MacAusland, Sonnenschein) of separation due to muscle pull. The 2 cases in this group occurred in the same patient. The first separation appeared on the right side at 13 years of age and 1 year later separation of the opposite side occurred. In both instances the history of the accident was the same. While running, the patient fell, experienced sharp pain in the upper inner thigh and was unable to walk. Examination of the injured part showed no shortening, but tenderness and swelling over the upper inner thigh and inability to flex the thigh. This patient made a complete recovery of function after fixation of the legs in spica casts (Fig. 33).

EPIPHYSEAL SEPARATION OF THE LOWER FEMUR

Injuries about the knee joint in the growing age most often result in sprains or injuries to the cartilages of the joint. Only severe trauma causes fractures or separations of the epiphyses. There were but 10 such injuries in this series, divided as in Table X.

The lower femoral epiphysis is believed to be the only epiphysis showing an ossification center at birth. By the fourth year, it has become largely calcified, but it does not unite with the shaft

Fig. 34.

Fig. 35.

Fig. 36.

Fig. 34. Thomas W., aged 13 years. Leg was twisted in a football tackle, November 15, 1925. Separation of the lower epiphysis of the femur with the typical anterior displacement.

Fig. 35. Roentgenogram of the same patient as in Figure 34, after reduction. The leg is dressed in the flexed position.

Fig. 36. Same patient as in Figure 34. Roentgenogram 7 years after separation of epiphysis. Firm bony union. One inch shortening, good functional result.

until the twentieth year or even as late as the twenty-fifth year in some cases. According to Ollier, the growth from the lower epiphysis of the femur is about twice that from the upper. The diaphyseal surface of the epiphysis assumes a shallow cup-shape with a median anteroposterior ridge which fits into a shallow groove between the blunt projections of the condyle portions of the diaphyses. The epiphysis includes the whole of the articular surface of the femur and lies almost entirely within the synovia of the knee, and to it are attached the strong crucial and lateral ligaments of the joint.

Separation of the lower femoral epiphysis is the most common epiphyseal injury in the region of the knee. Indirect violence is the most frequent cause, the tibia acting as a lever to produce hyperextension in the knee joint through its strong ligamentous attachments. In addition, there is often added the factor of torsion. The injury is often spoken of as the "cartwheel fracture" because it was frequently caused by catching the leg in the revolving wheel of a wagon in the days when horse drawn vehicles were more common. In the present day other types of trauma are by far the more common. The separation occurs most frequently between the ages of 8 and 14. The displacement of the epiphysis is usually anterior, carrying with it the tibiofemoral articulation, and producing a hemarthrosis of the knee joint. The sharp posterior edge of the diaphysis projects downward and backward into the popliteal space (Figs. 34 and 35). This displacement is the cause of the frequent complications of the injuries, viz., injuries to the popliteal vessels and nerves, often necessitating amputation or causing paralysis. Before attempting reduction, an examination should be made, especially for signs of injury to the popliteal vessels and nerves. MacAusland and Moorehead emphasize the importance of aspiration of the knee joint in recent injuries. This relaxes the tension in the joint and makes the reduction easier. Reduction is best accomplished by manipulation under general anæsthesia with fluoroscopic control. The knee is hyperextended and then by traction upward on the thigh and downward on the leg, the epiphysis is replaced in its normal position as the knee is flexed.

According to Patterson, there is little tendency to displacement once reduction has been accomplished. He applies traction with early passive and active motion. A plaster-of-paris cast, holding the leg in acute flexion, is the usual method of treatment, but Cotton and Griswold have discarded this dressing because of the discomfort produced and now maintain the acutely flexed position by simple adhesive. To avoid disability in the knee joint, early motion is advised and Griswold reports an excellent result in a case in which motion in an adhesive dressing was given, beginning on the day after reduction. Although primary operation is advised by some surgeons (Patterson), it seems better to reserve this radical procedure for the late cases or those which cannot be reduced by manipulation under the fluoroscope.

In this series there were 3 cases, all having the typical anterior displacement of the epiphysis. One patient was 12, and the other two 17 years. The youngest patient fell backward with his foot

TABLE X

	Cases
Fractures of the lower femur	4
Fractures of head of tibia	3
Epiphyseal separation lower femur	3

Fig. 37.

Fig. 38.

Fig. 39.

Fig. 37. Clarence W., aged 10 years. Struck from the side in football. Epiphyseal separation of lower tibia with fracture of the diaphysis and of the lower fourth of the fibula.

Fig. 38. Same patient as in Figure 37, after reduction and the application of lateral molded plaster splints.

Fig. 39. Same patient as in Figure 37, 5 years later. No shortening. Normal functional result.

caught in an iron step; the 2 other displacements occurred in automobile accidents.

In all 3 cases good reduction was obtained by manipulation under fluoroscopic control. In one patient, the dorsalis pedis and posterior tibial gave no pulsation before reduction and, in spite of the reduction, gangrene of the leg developed, necessitating amputation. Perfect anatomical and functional results were obtained in one of the other patients. The third patient had an excellent functional result, but about three-quarters of an inch shortening. Roentgenogram shows premature ossification (Fig. 36).

Separation of the upper epiphysis of the tibia occurs very rarely. It is usually the result of direct violence. There are no cases of this injury in this series.

EPIPHYSEAL SEPARATION ABOUT THE ANKLE JOINT

Separations of the lower epiphyses of the tibia and fibula occur not infrequently in injuries at the ankle during the epiphyseal age. Thirty-four injuries in this period taken from the records of the Department of Roentgenology were divided as in Table XI.

Of the 34 injuries of the ankle region in the epiphyseal age, 6 (18 per cent) were epiphyseal separations alone or associated with fractures. The lower epiphysis of the tibia begins to ossify during the first year of life. By the fourteenth or fifteenth year practically the whole epiphysis is osseous except the thin line of the epiphyseal cartilage. It unites with the shaft during the eighteenth or nineteenth year. The line of the epiphysis is nearly transverse, but its upper surface is traversed by irregular ridges which fit into depressions on the diaphysis to make a rather firm union. The epiphysis forms the entire weight bearing surface of the tibia and the internal malleolus. To its outer edge are attached the strong tibiofibular ligaments.

Most of these injuries are caused by abduction and torsion of the foot or by direct violence (Bishop). The usual displacement is posterior but in the majority of cases the separation is slight in amount. In practically all the cases there is an

TABLE XI

	Cases
Fractures	
Lower tibia	6
Lower fibula	11
Both bones above ankle	7
Astragalus	4
Epiphyseal separations	
Lower tibia	1
Lower tibia and fracture fibula	2
Lower tibia and fracture fibula and calcaneous	1
Lower fibula	2

TABLE XII.—SUMMARY

Epiphyseal separations	Cases	Cases followed	Good results	Poor results
Lower radius	48	28	28	..
Lower ulna	9	6	5	1*
Upper radius	1	1	1	..
Olecranon	1	1	1	..
Lower humerus	36	24	17	7
Upper humerus	2	2	2	..
Head of femur	2	2	1	1*
Lesser trochanter	2	2	2	..
Lower femur	3	3	1	2†
Lower tibia	4	4	4	..
Lower fibula	2	2	2	..
	110	75	64	11

*Premature ossification.
†1 premature ossification, 1 amputation.

associated fracture of the diaphysis or of the fibula (Figs. 37 and 38).

In this series there were 4 patients, 10 to 15 years of age. The epiphyseal separation was associated with a fracture in all but 1 case.

The treatment consists of fluoroscopic reduction with the application of lateral molded plaster splints. The splints should be removed at frequent intervals after the first week to give active and passive motion to the ankle joint. After removal of the splints in 4 weeks an elastic bandage or adhesive strapping will prevent excessive swelling during the first few weeks of weight bearing.

The results in the 4 cases were all good. Two patients came for treatment 2 weeks after their injuries. There was fixation of the fragments; in 1 case the epiphysis was considerably displaced posteriorly. Fixation dressings were applied for 2 more weeks. The results in these 2 patients were as good anatomically and functionally as in the cases with good reduction and immediate treatment.

The separation of the lower epiphysis of the fibula is a rare accident. This epiphysis, which begins to ossify during the second year, unites with the shaft during the twentieth to the twenty-second year. This epiphysis is the exception to the general rule that epiphyses appear last and unite first when the nutrient artery runs toward them. The nutrient artery of the fibula courses downward, but the lower epiphysis appears before the upper and unites with the shaft after it.

The lower fibular epiphysis does not articulate with the tibia, but is joined to it by the strong tibiofibular ligaments. The epiphysis forms the lateral mortise of the joint and the external malleolus.

There were 2 cases of separation of the lower epiphysis of the fibula in this series. Both patients were boys, 15 and 17 years of age, in whom severe direct violence was the etiological factor. There was only slight displacement of the epiphysis, and the chief symptom was the marked swelling of the outer side of the ankle. Lateral molded plaster splints with a short period of elevation produced perfect results in each case.

DEDUCTIONS FROM OUR STUDY

From the results obtained in the treatment of these epiphyseal injuries it is permissible to draw some conclusions which may be useful in the future management of such cases.

1. Perfect reposition of the displaced epiphysis does not necessarily insure subsequent normal growth. (In this series there were only 3 cases of premature ossification of the epiphyseal cartilage. In all 3 instances perfect anatomical reduction was accomplished soon after the injury. The case of premature ossification at the lower ulna has no apparent cause. The second case, one of slipping upper femoral epiphysis, may be explained partially on the basis of an osteochondritis involving the epiphyseal cartilage. The third case at the lower femur was well reduced.)

2. In most instances in our series in which a single epiphysis forms the joint surface, partial reposition of the epiphysis was followed by normal subsequent growth (2 to 8 years). This statement is particularly true of the lower radial epiphysis. Especially in the younger age groups nature seems able to compensate for considerable displacement.

3. Perfect reposition is most desirable in those areas where several ossification centers are involved in the formation of the entire epiphysis, e.g., lower humeral epiphysis. Displacement of these epiphyses and subsequent abnormal overgrowth may give marked impairment of motion in such a complicated joint.

4. Injuries in the region of joints during the growing age, even in the absence of roentgen-ray evidence, should be considered as possible epiphyseal separations without displacement. Treatment should be carried out with this possibility in mind.

5. The prognosis of epiphyseal injuries should be guarded because of the danger of premature ossification and because the extent of the injury cannot always be determined at the time of injury.

SUMMARY

A review of 110 epiphyseal separations is presented, and relative comparisons have been made between the incidence of these injuries and fractures in the region of joints in the growing age. The results may be summarized as in Table XII.

Of the cases followed, 85.3% obtained good anatomical and functional results. The results were fair or poor in 13.3% of the followed cases, the majority of these being in epiphyseal injuries of the lower humerus. The three cases with premature ossification have excellent functional results but have been classed with the poor results because of the slight anatomical deformity.

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PRIMARY OSTEOGENIC SARCOMA OF THE THYROID GLAND

Report of a Case

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KETTLE, in 1919, called attention to the polymorphic capability of malignant epithelial cells, also to the fact that the cells of some carcinomata are polymorphic to the extent that they lose all trace of their epithelial origin and may become indistinguishable from cells of a connective tissue lineage. The tendency of the cells of a number of carcinomata of the thyroid gland to imitate those of malignant connective tissue neoplasms, an activity especially noted by Kettle and Ewing has probably led to reports of an incidence of primary sarcoma of the thyroid gland that is entirely too high. It is our opinion that the more the microscopic features of malignant neoplasms of the thyroid gland are studied in detail, the closer is the agreement with Ewing that undoubted primary sarcoma rarely occurs. If sarcoma in general rarely has its inception in the thyroid gland, it is reasonable to assume that the occurrence of a primary osteogenic sarcoma that is not a part of a mixed tumor or of a teratoma really borders on the unique. Reports of such cases in the literature are extremely rare.

One of the earliest, if not the earliest, report of such a neoplasm was that made by Foerster in 1860. He observed a compact nodule of bone imbedded in a spindle cell sarcoma of the thyroid gland of a woman aged 60 years. He was of the opinion that formation of the bone and of the neoplasm were independent processes, but that both originated in the connective tissue of the thyroid gland. It seems safe to assume that the bone in his case was a product of the sarcoma.

Pick, in 1892, reported a case of malignant tumor of the thyroid gland of a woman aged 51 years. The patient had had a tumor of the neck for several years but one of the soft palate had recently developed. Excision of the tumor of the soft palate was soon followed by death, and at necropsy the tumor in the neck was found to be composed almost entirely of bony tissue, with soft tissue on the periphery. Microscopically, the tumor was composed of spindle cells, much fibrous tissue, and bone. Pick observed transsitional tissue between bone and sarcoma, as well as the purely sarcomatous and purely bony tissue. Metastasis was observed in the soft palate, lungs, heart, lymph nodes of the neck, liver, stomach, intestine and dura mater. One of the metastatic nodules in the lung contained bony tissue. Pick thought that in this case the bone originated by transformation of the sarcomatous tissue.

Funkenstein, in 1903, described 2 cases of sarcoma of the thyroid gland in which cartilage and bone were produced. He was of the opinion that his cases were similar to the case described by Pick. Metastatic growths were numerous in both of his cases, and some of the metastatic nodules were purely sarcomatous. He considered the lesions in his cases to be osteochondrosarcomata, and thought, as did Pick, that the bone originated from the sarcomatous tissue. He was also of the opinion that the absence of bone in some of the metastatic nodules simply meant that these nodules were so recent that the sarcomatous tissue had not had time to form bone.

Chavannaz and Nadal-Pierre, in 1910, reported a case of sarcomatous tumor of the thyroid gland composed of spindle cells, cartilage, and bone, similar to the cases reported by the authors named in the foregoing. Solaro, in 1913, reported a case of osteosarcoma of 8 months' duration that developed in the left lobe of the thyroid gland of a man aged 46 years. The lesion was excised and was found to be a spindle cell sarcoma containing much bone and cartilage; the bony tissue appeared to be normally formed. The tumor recurred 2 months after operation and, when excised, the recurrent tumor was also found to be a spindle cell sarcoma, but only a few nodules of bone could be seen. Like Pick and Funkenstein, Solaro was of the opinion that the bone was formed from the sarcoma. He was furthermore of the opinion that the scarcity of bone in the recurrent tumor could be explained on the hypothesis that the growth was so rapid that there was no time for the production of bone. He considered that the sarcoma might have originated in an osteogenic rest of the thyroid gland derived from the branchial apparatus; however, he was more inclined to the opinion that it

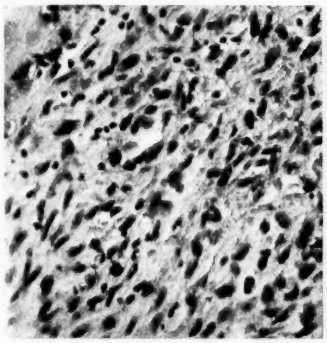

Fig. 1.

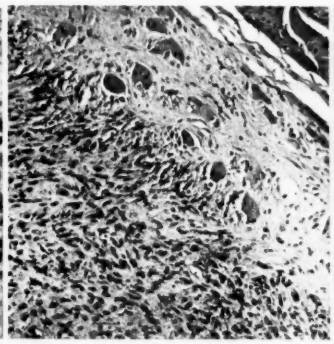

Fig. 2.

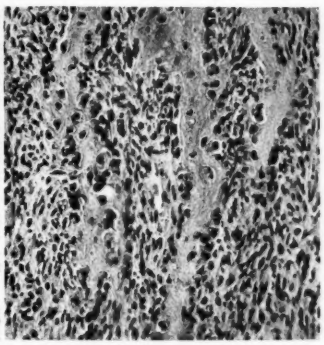

Fig. 3.

Fig. 1. Polymorphic sarcoma cells, with scattered mitotic figures.

Fig. 2. Sarcoma cells: invasion from within outward of the adjacent muscle tissue is readily noted.

Fig. 3. The development of sarcomatous osteoblasts out of the sarcoma cells and the formation of osteoid tissue.

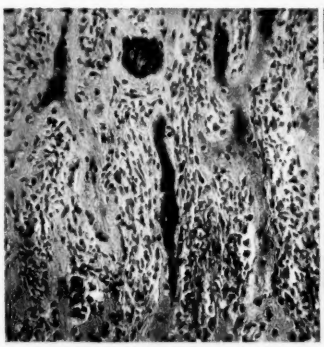

Fig. 4.

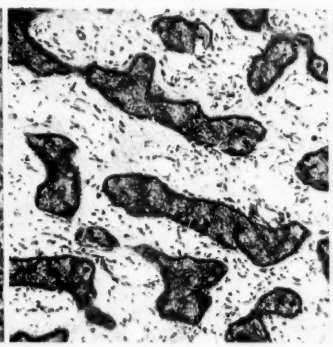

Fig. 5.

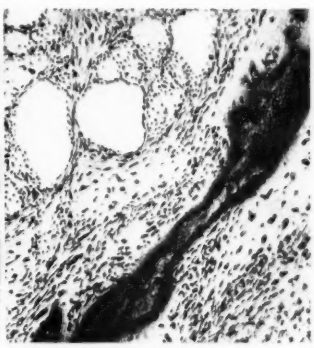

Fig. 6.

Fig. 4. The development of osteoid tissue into true bone with osteoblasts.

Fig. 5. An area of true bone in which the osteoblasts have for the most part disappeared, thereby simulating the picture of a bony sequestrum, is shown in the photomicrograph.

Fig. 6. An area of thyroid follicles, with true bone lying in close proximity to them.

originated as the result of direct metaplasia of connective tissue.

The case reported by us is the first of its kind that has been observed at The Mayo Clinic in the course of pathological examination of approximately 40,000 thyroid glands.

REPORT OF CASE

A man, aged 71 years, entered the clinic January 31, 1933, complaining of a growth in the right side of the neck of 4 months' duration. His earlier history was not of special significance, except that January 10, 1916, a squamous cell carcinoma graded 1 was excised from his lower lip at the clinic. At that time, the submental, right and left submaxillary lymph nodes and the right and left submaxillary salivary glands were removed. 'Examination of the lymph nodes and salivary glands did not reveal any evidence of metastasis. There was no evidence of recurrence of the carcinoma of the lip. The lesion in his neck had developed gradually; hoarseness and cough had been present for 3 weeks, and the patient had lost 5 pounds in the last 2 months.

In the right side of the neck, between the common carotid artery and the trachea, a hard, partially fixed mass, 6 by 6 centimeters in diameter, was noted. The growth had displaced these structures respectively to the right and left, and moved with the trachea. The right vocal cord was fixed in the median line, and there was some bulging of the lower part of the right lateral wall of the hypopharynx. A clinical diagnosis of carcinoma of the thyroid gland was made.

An exploratory operation by one of us (Pemberton) revealed a tumor involving the right lobe of the thyroid gland. This tumor was firmly adherent to the side of the trachea and larynx, and was also adherent posteriorly along the line of the blood vessels. A specimen of the tumor was removed for biopsy. Microscopic examination revealed that the lesion was an osteogenic sarcoma. Ten 5-milligram radium needles were inserted into the substance of the tumor 1 to 1.5 centimeters apart, and were left in

place for 24 hours, making a total dose of 1,200 milligram hours. The sarcoma caused death October, 1933.

Microscopic examination. The neoplasm was varied in structure, for in some areas there were only polymorphic sarcoma cells, a few of which were in a state of mitosis (Fig. 1). In other areas sarcoma cells invaded the adjacent musculature from within outward (Fig. 2). In still other areas could be seen sarcomatous osteoblasts which had arisen out of the sarcomatous tissue and which in turn were making osteoid tissue (Fig. 3). Also could be seen the transformation of osteoid tissue into true bone by osteoblasts that were indistinguishable from normal osteoblasts (Fig. 4). Such areas led directly into areas of bony tissue which had no resemblance to sarcoma. This bony tissue with its scanty and atrophic osteoblasts, resembled to some extent a bony sequestrum (Fig. 5). In different parts, islands of thyroid follicles were seen, some of which had bony tissue in close proximity (Fig. 6).

The question arises, how can one account for the presence of a primary osteogenic sarcoma in such an unusual situation? The hypothesis that it arose from embryonic rests may explain the presence of this and similar neoplasms in odd situations. We are of the opinion, however, that it is not necessary even to consider such an hypothesis in this case, for the most tenable idea is that the sarcoma arose from the stroma of the thyroid gland by dedifferentiation or anaplasia, of fibroblasts. By taking the latter view we are in practical agreement with the concept of origin held by Foerster and by Solaro. We agree with Pick, with Funkenstein and with Solaro that the bone is a direct descendant of sarcomatous tissue, and in support of this contention Figures 1 to 6 reveal the steps in the process of cellular differentiation by which the sarcoma cells produce sarcomatous osteoblasts, which in turn produce osteoblasts that are indistinguishable from those of benign osteoblasts, followed by the formation of osteoid tissue and true bone. Furthermore, this supports the contention that we are dealing with a true osteogenic sarcoma in contradistinction to a sarcoma enveloping osteoid tissue or bone.

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OPERATIVE TREATMENT OF BILATERAL NEPHROLITHIASIS

Indications and Results

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OPINION is more or less uniform regarding the indications for surgical intervention in the presence of unilateral nephrolithiasis; great differences of opinion still exist, however, as to the best means of treating bilateral renal and ureteral calculi. Some recommend surgical intervention only in cases in which anuria, total obstruction associated with high temperatures, and other conditions similarly menacing call for an emergency operation. Another group, to which I belong, consider bilateral lithiasis so harmful to the renal parenchyma, that except in certain special cases they favor early removal of the calculi on both sides. A study of 15 personal cases in which the patients survived operation furnishes further justification for my attitude.

Bilateral renal calculi are found in 8 to 20 per cent of the cases of nephrolithiasis. The percentage has not increased within the last decade, notwithstanding the fact that in most countries the number of cases of renal lithiasis has greatly increased—a fact which may throw some light on the probable causes of stone formation. It is hardly possible that the increase in the number of cases of renal calculi is due only to improved methods of detection and investigation or to other extrinsic factors. It would seem, however, that the stability in the percentage of bilateral cases militates against the assumption that diathesis, or constitutional or metabolic processes are *solely* responsible for the formation of calculi and the increase in their frequency. Fedoroff's belief that the relative low percentage of bilateral lithiasis stresses the influence of local conditions on the formation of stones, seems far more correct.

Of late more has been learned about the causes of the formation of a type of stone commonly called secondary or inflammatory calculus, which develops in bacteria laden urine, while the "primary" calculus develops in aseptic urine. In a series of excellent clinical studies, Hellström clearly demonstrated the powerful influence of cocci infection in the production of secondary stones. I have verified and confirmed his statements by clinical observation, examination of calculi, and by experiments on animals. Of 43 microscopically examined secondary phosphatic stones, 37 (or 86 per cent) contained staphylococci, even when the urine sediment revealed other bacteria and absence of cocci.

I injected cultures of bacteria from lithiasis cases into the ear vein of rabbits in which I had previously produced a slight stricture of the left ureter. Concrements or sand developed in 9 of the 13 animals infected with staphylococci, whereas in another 6 rabbits infected with other bacteria, such as Bacillus coli, lactis, aerogenes, and proteus, sand or concrements could never be found, although X-ray examinations and necropsy were performed.[1]

I have laid stress upon this bacterial cause of lithiasis because in a great number of cases the presence of bilateral renal calculi is due to infection by staphylococci, as will be seen later on. It is of great importance to be able to recognize this type of stone because of certain indications for the operative and postoperative treatment.

Other well known causes of calculi formation in which staphylococci often play an active part are (a) diseases and fractures of the bone and injuries of the spine, (b) prolonged immobility, the result of illness or injury. The occurrence of bilateral lithiasis is particularly frequent after the injuries mentioned, which agrees with our conception of some of the causes of stone formation. (c) Foreign bodies, like blood clots, etc., may form the nucleus around which a stone may develop; the so called (post-) traumatic stones are thus formed.

However, though something has been learned about the pathogenesis of secondary stones, we still know but little as to what are the causes of the formation of "primary" stones, especially the urates and oxalates. One is inclined to assume that a congenital abnormality in the urinary system may play an important part in their formation. For example, I once removed a pyonephrotic kidney in a little girl aged 5 months, who had an ectopic ureter leading into the vestibule of the vagina. About the same time I operated on her father to remove a urate stone in the kidney. The family history of patients with stones will often reveal kidney diseases among relatives. However, we presume that a change in the normal balance between crystalloids and protective colloids in the

[1] A short summary of these experiments has lately been published (Klin. Wchnschr., 1933, Nr. 2).

urine or changes of their state of dispersion or in their chemical nature are the determining factors in the formation of a stone nucleus. Certain anatomical or physiological changes in the organs must also have taken place in order to favor the formation and retention of stones within the organ. At any rate we may conclude that several concurrent factors are always required in the formation of a kidney calculus.

TREATMENT OF BILATERAL NEPHROLITHIASIS

Should bilateral renal or ureteral calculi be treated surgically or conservatively? To our surprise, the literature still reveals a number of surgeons opposed to the operative treatment; others believe that surgical intervention is indicated only in a very few cases (Fedoroff, Kraas, Rosenstein). The majority of surgeons, however, prefer the more radical treatment (Blum, Hinmann, W. Israel, Ravasini, Smith). Before we state our preference, we would stress the fact that we apply the term "bilateral nephrolithiasis" only to those cases in which stones are found on both sides *at the same time.*

We believe that removal of stones is contra-indicated when they are aseptic stones: that is (a) the stones are so small that it is more or less likely they will be spontaneously expelled sooner or later; (b) the stones are fixed in a calyx and cause neither colic nor hæmorrhage and cause no obstruction to the urinary flow (so called "silent stones"); (c) non-infected large calculi or coral stones; (d) calculi so numerous that the chances of complete removal of all of them are almost nil. All other aseptic stones should be removed by operation, especially if their location and size are likely to damage the renal parenchyma.

As for calculi in infected urine, we must adhere to the general principle that such stones should be removed operatively as soon as possible. This is especially true if the stones are of staphylococcic origin; the progressive destruction of the renal parenchyma is almost a certainty if these stones are left to grow rapidly as they usually do. If we operate too late, the danger of recurrence will be very great.

From this general rule we would exclude those very small stones which are apt to be expelled spontaneously without too great risk of completely obstructing the ureter. A ureteral obstruction, if at the same time the urine were infected with staphylococci, might rapidly bring about complete destruction of the renal parenchyma. We believe that it is better to remove a small stone at once than to be compelled later to perform an emergency operation made necessary by high fever, chills, renal abscesses or pyonephrosis. Under such circumstances, it is often impossible to remove the whole stone, or all of the stones, in which case it would be necessary to perform a second operation later on. For instance, if a ureteral stone completely obstructs a greatly damaged and infected kidney, we make it a rule to perform a nephrostomy first; we do not search for the stone unless we can reach it and remove it through the same incision and without difficulty.

It is difficult to establish general rules as to treatment in the presence of infection and branching stones in both kidneys. The course to take may depend upon various factors, such as the age of the patient, his general condition, the virulence of the infection or whether the patient suffers with colic or fever. The social position of the patient must also be considered, as often it may be necessary to establish a kidney fistula which the patient may have to endure for the rest of his life. Often nephrostomy is the only possible operation in the presence of infection and coral stones, when on account of the poor condition of the kidneys nephrectomy of one is definitely contra-indicated. Nephrostomy in such cases puts an end at least to the progressive destruction of the kidney. The removal of the foreign body, the relief of pressure in the renal cavities, and the abatement of the infection often do much toward recovery of the renal functions (see Cases 8, 10, 13). Removal of such stones without the institution of a permanent kidney fistula often results in early recurrence of stone formation and the beneficial effects of the operation are completely lost.

Naturally it is advisable to refrain from operation in cases of large coral stones. That good results have been obtained by operation even in cases with enormous calculi has been clearly demonstrated by numerous cases reported in literature. Though complete recovery of kidney function is not possible in such cases we may be well satisfied if by operation we have at least prolonged the patient's life.

We believe that the radical treatment of cases of bilateral nephrolithiasis is justified when we consider the danger which the presence of every stone imposes upon the renal parenchyma and the function of the kidney pelvis. As every stone is a foreign body, it not only disturbs the finely coordinated neuromuscular mechanism of the uropoetic system on the diseased side, but also it damages the renal parenchyma by mere pressure and by the permanent or the intermittent stagnation in the urinary flow in the pelvis or in the calyces. This stagnation favors the growth of the stone. Thus a vicious circle is produced and the

condition becomes even more grave when infection, which sooner or later always sets in, speeds up the otherwise slow process of destruction to almost calamitous rapidity. We quite agree with J. R. Caulk, who says: "A stone in the kidney is actively or potentially a menace—actively if accompanied with infection—potentially if not."

Our task is far from being finished once we have removed the stone surgically. This is only the first step in the treatment, the aim of which must be the prevention, as far as possible, of stone recurrence. Prophylactic treatment must be started at once, in fact during the operation itself, inasmuch as we must try never to leave behind any fragments of the calculus (X-ray control during operation) and to ensure a free outflow of the urine (either by nephropexy, freeing the ureter from adhesions, or by plastic surgery).

Immediately after the operation we must combat the possibility of recurrence by means of an increased intake of fluids, by diet in order to alter the urinary reaction as determined by the chemical nature of the stone, and by treating the infection, if present, with antiseptic medication.

Once we have decided to operate, our first problem is to decide on which side to operate first —whether there is a possibility of performing the operation in one stage or whether it must be done in two stages.

Literature gives us but few instances in which a one stage operation has been done to remove bilateral calculi. V. Blum, in 1923, was the first to recommend this method. In 1930 I reported 8 cases in which a one stage operation had been done by him, and added 5 cases of my own, all patients surviving. Kuemmell and Judin also believe that in certain selected cases the one stage operation is indicated. Among the numerous interventions for bilateral renal calculi reported in literature, the one stage operation is very seldom mentioned. The only ones I could find were 4 cases reported by Leschnew and Levant (2 cases of pyelotomy on both sides, 1 case of pyelotomy and nephrectomy), 1 case by Tenani (bilateral pyelotomy), 1 by Mamikonoff (pyelotomy and nephrotomy), and 1 by Lobmeyer (pyelotomy and ureterotomy). Frangenheim and Dziembowski have each reported 2 cases of bilateral pyelotomy in one stage. All patients survived operation, so that together with my own 7 cases 26 cases have been reported, without mortality.

We regard the one stage operation for bilateral nephrolithiasis the ideal method and we resort to other methods only when extremely grave conditions confront us: when the patient is very old; when the patient is very fat and there is an associated severe infection; when the patient's condition is extremely precarious and complicated by high fever because of complete blocking by the stone; when the general condition of the patient is bad, the non-protein nitrogen content of the blood being above 50 milligrams per cent. At times operation on the first side is more difficult and requires more time than anticipated and we are forced to abandon our plan of performing the operation on both sides at the same sitting.

The type of operation is of less importance to us; though we prefer pyelotomy we are not averse to nephrotomy. After the stone has been accurately localized, we are able to remove it through a small incision in the parenchyma. It has become more and more recognized that a small circumscript nephrotomy is not a dangerous procedure entailing postoperative complications or serious damage to the parenchyma. We have always adhered to this belief and experience has confirmed our opinion. We have not only performed in one stage pyelotomy on both sides, but we have also done a nephrotomy on one kidney and a pyelotomy on the other side; or we have done a nephrotomy together with nephrectomy. In all cases recovery proceeded without complications.

Let us enumerate the advantages of the one stage over the two stage operation at more or less prolonged intervals. I will repeat the advantages which I have already enumerated in a paper published 3 years ago.

1. Both kidneys are at once freed of the foreign bodies, of infection and stagnation, and as far as possible are restored to normal functional conditions.

2. Local postoperative treatment against infection can be started at once on both sides. If the operation is done in two stages, the infection in the kidney not operated upon persists and is a latent danger to the kidney already treated. Then, too, every operation, forcing the patient to become inactive, not only weakens his organism but retards the urinary outflow and this may be particularly detrimental, as we have demonstrated in those cases in which stone formation takes place after spinal injury. Finally, the local postoperative treatment of the kidney first operated on must be interrupted during convalescence after the second kidney has been operated upon. The whole course of the postoperative treatment is unnecessarily prolonged because of the interval between the two operations. As the local treatment must be continued until the urine is quite free from infection, it is apparent that convalescence after a two stage operation is much longer than after the one stage operation.

TABLE I.—ONE STAGE OPERATIONS

Number Sex Age-years	Type of infection	Operation on		Type of stones	Ulterior results
		I side	II side		
1 F. 28	Staphylococci	Pyelotomy	Pyelotomy	Phosphates	Died 3 years later with tuberculosis of the lung. Kidneys healthy
2 M. 36	Bacillus coli	Pyelotomy	Nephrostomy	Left: oxalate right: urate	Recovered
3 M. 47	Staphylococci	Pyelotomy	Nephrotomy	Phosphates	Recovered, though small fragment of stone was left behind
4 M. 49	Staphylococci	Nephrotomy	Nephrectomy	Phosphates	Recovered, though small fragment of stone was left behind
5 M. 48	Staphylococci	Pyelonephrotomy	Nephrectomy	Phosphates	Recurrence, died 15 months later with parotitis
6 M. 42	Staphylococci	Pyelonephrotomy Horseshoe	Pyelotomy kidney	Phosphates	Recovered
7 M. 54	Sterile	Ureterotomy	Ureterotomy	Oxalates	Recovered

3. The side not operated upon remains a source of latent danger to the patient, subjecting him to possible complications such as hæmaturia, colic, blocking of the kidney, fever, pyelonephritis or even the formation of renal abscesses, all of which are avoided when the complete operation is done in one stage. The literature contains reports of numerous cases in which complications attributable to conditions on the side not operated upon arose during the first few days after the first operation.

4. Every complication which may arise after the first operation (pneumonia, thrombosis, suppuration, etc.) may prolong the interval between the two stages. According to Rosenstein at least 6 to 8 weeks should elapse between the first and second stages. Such a considerable length of time may cause irreparable damage to the kidney not yet operated upon. Under the circumstances it is easy to understand the reluctance of the doctor as well as of the patient to run the risk of a second operation.

5. The patient himself will always prefer the one stage operation. In fact, several of our patients even refused to have a two stage operation and gladly submitted to the one stage procedure. For the patient the advantages of the one stage operation are obvious. Once the operation is over, they can look forward to final recovery and do not have to face the prospects of a second operation as serious as the first one. Convalescence, after the one stage operation, is no longer than after each operation of the two stage procedure. Not only the physical, but also the financial burden is reduced to half what the patient would have had to bear if the operation had been done in two stages. A further advantage is that he may look forward to normal life and normal work in half the time.

6. Many authors fear that after a one stage operation both kidneys may stop functioning for some time and that anuria may result. Truly this never happens. Even after bilateral nephrotomies carried out in the morning, the urinary function usually begins again in the afternoon and the urine collected through the nephrostomy drains becomes macroscopically blood free on the second, sometimes on the third day, after operation. Naturally the patient must be given a large amount of fluid (either *per os*, per rectum or hypodermically).

A study of our own cases, in 7 of which operation was done in one stage and in 8 in two stages, all without postoperative deaths, confirms all our views. Because of the great variation in the clinical picture presented in cases of bilateral nephrolithiasis, we cannot establish precise rules as to when a patient should be operated upon in one stage and when in two stages. Probably such rules can never be made. Very careful examination and preliminary treatment are always necessary and will reveal conclusive data which will enable us to select the type of operation which should be used in each case.

TABLE II.—TWO STAGE OPERATIONS

Number Sex Age-years	Type of infection	Operation on		Type of stones	Ulterior results
		I side	II side		
8 M. 50	Bacillus coli, cocci	Nephrostomy (emergency op.)	Nephrectomy 13 months later	Phosphates	Died a few months later with cancer of the stomach
9 F. 33	Bacillus coli	Nephrostomy (emergency op.)	Nephrotomy 7 months later	Phosphates	Recurrence on the left side
10 F. 42	Bacillus coli	Nephrostomy	Nephrostomy 8 months later (emergency op.)	Phosphates	Unknown
11 M. 50	Bacillus coli	Pyelonephrotomy	Nephrectomy 5 months later	Phosphates	Recurrence, permanent kidney fistula, good health
12 M. 50	Staphylococci	Ureterotomy	Nephrotomy 3 months later	Phosphates	Recovered
13 F. 17	Bacillus coli	Nephrostomy (emergency op.)	Nephrostomy 2 months later (emergency op.)	Phosphates	Recovered
14 M. 60	Staphylococci	Ureterotomy	Nephrectomy 1 month later	Phosphates	Unknown
15 M. 47	Staphylococci	Pyelonephrotomy	Nephrectomy 1 month later	Phosphates	Recovered

The indigocarmine test alone is not sufficient in these cases, as it does not give accurate information as to the condition of the renal parenchyma. The plain X-ray pictures must be supplemented with pyeloscopic examination of both sides, an indispensable measure as with no other means can we obtain so accurate a picture of the renal cavities and of the location of the stone. Intravenous pyelography may also be helpful as not only the condition of the kidney is revealed but also the function. During the preliminary treatment, it is of great importance to clear up the urinary infection as much as possible; and, though we cannot overcome it entirely as long as stones are present, local treatment, diet, and medications will do much to improve the condition.

The next question is, once we have decided to operate, which side shall we do first.

A. The one stage operation. If only one side is infected we naturally will operate first on the aseptic side. But if both sides are aseptic, or, as happens more frequently, if both sides are infected, we will have to operate first upon the kidney which demands the more conservative treatment. That is we will operate first upon the kidney which requires only pyelotomy, and then upon the kidney which requires either nephrotomy or even nephrectomy. We have repeatedly emphasized the necessity of always choosing the most conservative procedure in cases in which both kidneys are affected. The condition revealed by operation is often of far greater value in our decisions than all the preliminary functional and radiographic tests. The recuperative power of even severely damaged kidneys, once they have been freed of stones and are adequately drained, is generally marvelous (see Cases 10 and 13). Therefore, conservatism in the treatment of nephrolithiasis should be strongly emphasized. This is a principle which is readily understood by all those who have seen the astonishing results on renal function, which have followed a longstanding course of treatment by means of a kidney fistula and antiseptic medication.

B. The two stage operation. If it is necessary to resort to the two stage operation we will operate first, provided the functions of both kidneys are equal, upon the side which seems to be in the most danger as determined by the preliminary examinations; for instance if a stone in the ureter or kidney completely blocks or stagnates the flow of urine. If one kidney is infected and the other not, the infected side should be taken care of first. On the other hand if one kidney is damaged to such an extent that nephrectomy seems indicated, we will of course operate first upon the other kidney and delay the nephrectomy until the function of the first kidney is improved through adequate treatment. General rules like "first operate upon the better, then the worse

Fig. 1. Case 1. Pyelotomy on both sides in one stage.

side" are of no value. If satisfactory results are to be obtained, each case must be handled to meet the conditions present in the case at hand.

Sometimes, however, it is difficult to make a definite decision as to which side to treat first. In such cases we must always remember that it is easy to select the time for the first operation, but we never know when we will be able to perform the second operation, for all sorts of complications may intervene to delay the second operation indefinitely. In most cases, however, our decision will depend on the history of the case and the condition found in the individual patient.

The following brief histories of 7 of my own cases in which operation was done in one stage and of 8 in which operation was done in two stages confirm my contentions.

ONE STAGE OPERATIONS

Case 1. Marie St., female, aged 28 years. Urine from the bladder and both kidneys contained blood, pus, and staphylococci. Indigocarmine given intravenously appeared on both sides after 5 minutes (Fig. 1). Pyelotomy was done on both sides and phosphatic stones were removed. After operation and treatment the urine became clear, pus and bacteria disappeared. X-ray examinations remained negative until patient died 3 years later with tuberculosis of the lungs.

Case 2. Rud. A., male, aged 36 years. In 1914 patient sustained a severe bone fracture (war injury), and suffered prolonged immobility. He was examined in 1926. Severe pyuria with colon bacillus infection was found. He did not know when the pyuria began. On the right side there was an infected hydronephrosis with about 200 small urate stones; a large oxalate stone completely filled the pelvis and reached into one of the calyces on the left side. At operation a left pyelotomy and a right nephrostomy with removal of the stones on the right side were done. After 6 months of postoperative treatment, the left pelvis was free of pus and bacteria. Two years after the first operation nephrectomy of the drained kidney (Blum) was done. Five

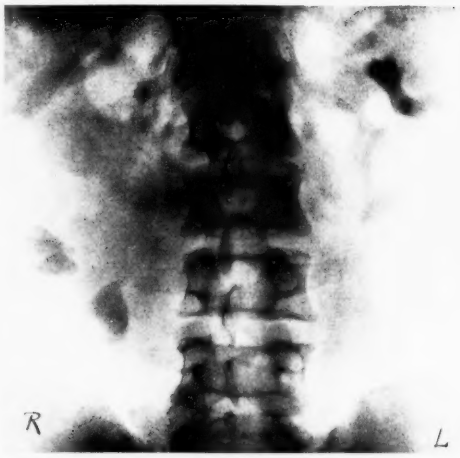

Fig. 2. Case 4. Intravenous pyelography. Left, double kidney, upper pelvis filled out by a stone. Right, big, infected hydronephrosis. Nephrotomy left and nephrectomy right in one stage.

and one-half years after the first operation, patient enjoys excellent health.

Case 3. Johann W., male, aged 47 years. Pus and staphylococci were present on both sides; there was complete obstruction by calculus in the left pelvis; and patient had a high fever. After drainage by means of an indwelling ureteral catheter, indigocarmine given intravenously appeared in 10 minutes on the right side and in 4 minutes on the left. July, 1928, a right pyelotomy was done and a left nephrotomy. A small fragment of a stone, the size of a millet seed, had been left in one of the calyces, as was revealed by X-ray examination before patient's discharge. This patient consequently refused all adequate postoperative treatment. Four and one-half years after operation the urine is slightly cloudy but an X-ray picture shows no increase in the size of the stone fragment.

Case 4. Dem. E., male, aged 49 years. There were two ureteral orifices on the left, one on the right side of the bladder. The urine of all three pelves contained pus and cocci. Large infected hydronephrosis was present on the right side, and the left upper pelvis was completely filled with a branching calculus. No dye was excreted from the right side; excretion was poor from the left opening which corresponded to the upper pelvis and normal from the lower pelvis (Fig. 2). In February, 1930, nephrotomy was done on the left side, nephrectomy on the right side and phosphatic stones were removed. A small impacted stone fragment had been left in the uppermost calyx, which on the X-ray plate was overshadowed by the large stone. Three years after the operation, the output of blue from both left openings was absolutely normal, the urine, clear, containing only a few leucocytes and few bacteria. The roentgenogram showed a very slight increase of the stone fragment.

Case 5. Franz Sch., male, aged 48 years. Calculous hydronephrosis was present on the left side, and a stone the size of a bean was noted in the lowest calyx of the right kidney. The urine on both sides contained pus and staphylococci. Indigocarmine failed to appear on left; on right it appeared in 4½ minutes (Fig. 3). Pyelonephrotomy was done on the right side, nephrectomy on the left side.

Fig. 3. Case 5. Pyelonephrotomy right and nephrectomy left in one stage.

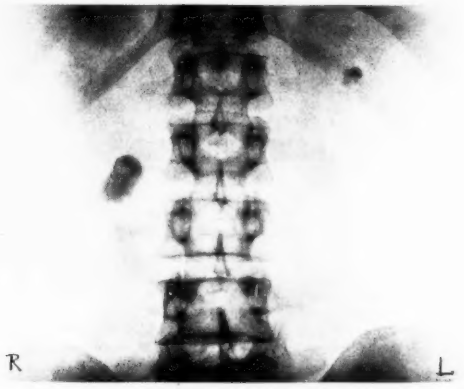

Fig. 4. Case 6. Horseshoe kidney. Pyelonephrotomy left and pyelotomy right in one stage.

Notwithstanding constant local treatment the urine could not be cleared of colon bacillus and cocci. Fifteen months later a stone, the size of a bean had developed and become impacted in the pelvic outlet. Patient had a high fever. A ureteral catheter could not be passed up alongside the stone into the pelvis; therefore operative removal of the stone was accomplished through a nephrostomy. The urine, which was heavily infected at the time of the operation, grew quite clear. Five days after the operation, patient developed bilateral parotitis (metastatic?) and died.

Case 6. Fritz B., male, aged 42 years, had a horseshoe kidney. In the urine from the bladder and both pelves, leucocytes and staphylococci were noted. Indigocarmine given intravenously on the right side was poorly excreted, after 6 minutes only. On the left side good excretion, after 3 minutes (Fig. 4). January, 1931, a small stone impacted in the top of a calyx made pyelonephrotomy necessary on the left side. The big stone on the right side was removed by pyelotomy. Two years after the operation patient is still under observation. The urine after repeated lavage of both pelves has grown quite clear, no pathological elements. Roentgenograms were negative.

Case 7. Karl A., male, aged 54 years. The urine was clear but showed traces of albumin; indigocarmine appeared on the left side after 12 minutes and was faint blue; on the right side there was no color at all. The X-ray examination revealed ureteral stones on both sides: on the right side about 20 centimeters, on the left about 5 centimeters above the bladder. The stone on the right side was the size of a hazelnut, on the left of a small bean. Intravenous pyelography revealed highly dilated calyces, pelves, and ureters. The non-protein nitrogen content of the blood was 52 milligrams per cent. On December 19, 1932, one stage operation was done on both sides; peridural anæsthesia with 60 cubic centimeters of ether was used. Irregularly shaped, fringed, oxalate stones were removed. Recovery was rapid without complications. Patient was discharged 16 days afterward. Indigocarmine was given at that time and was excreted fully blue after 8 minutes on the left side, faintly colored after 13 minutes on the right side.

TWO STAGE OPERATIONS

Case 8. Karl N., male, aged 50 years, had frequent colics on both sides since 1909, often with expulsion of stones. In August, 1926, severe pyuria was noted and the colon bacillus and cocci were found. X-ray examination revealed stones in both kidneys. On account of the high fever and the swelling of the kidney, nephrostomy was done on the right side (Blum, August, 1926). The kidney was filled with stones and purulent urine, and the parenchyma heavily damaged. A phosphatic stone which obstructed the upper part of the ureter could be removed only after a time. During the year after operation stones were frequently expelled and the patient suffered with colic on the left side.

In October, 1927, nephrectomy of the completely destroyed pyonephrotic kidney was performed on the left side. Convalescence was rapid. Five months later, however, the patient died of cancer of the stomach. The postmortem condition of the right kidney could not be obtained.

Case 9. Marie W., female, aged 33 years, had had coxitis during childhood which had kept her bedridden for 2 years. Fistulæ had long been present. She had suffered with colic on the right side ever since her childhood illness. In November, 1926, Basedow symptoms were noted, the urine contained many leucocytes and colon bacilli. Indigocarmine given intravenously did not appear on the right side after 10 minutes; on the left side the dye appeared in 4 minutes and was a pronounced blue. X-ray picture revealed stones widely separated on the right side and numerous small and large stones on the left side. Patient refused to undergo operation.

In August, 1927, she had high fever. The right kidney was much enlarged and painful, so nephrostomy had to be performed instantly. The kidney pelvis was found to be greatly dilated and filled with purulent urine. All stones were removed except 4 small ones which had to be left, because the serious condition of the patient did not allow us to prolong the operation. These stones were all expelled spontaneously in the following 5 months. The kidney was drained for 2 months, and the fistula closed a few days after removal of the rubber drain.

In March, 1928, operation was done on the left side. Stones were found in nearly all of the calyces. Two stones could not be found notwithstanding thorough exploration. After operation frequent lavage of the pelves was carried out. On the right side there was no recurrence of stone. On the left, the stones lying in a calyx slowly became so large that in February, 1932, these had to be removed through a

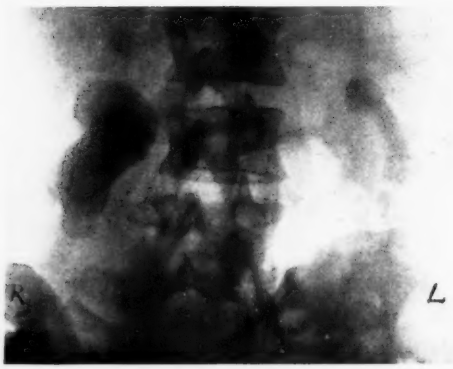

Fig. 5. Case 10. Nephrotomy on the right and nephrostomy on the left side in two stages.

nephrotomy. Soon after this the patient left Vienna for 5 months. She came back with hæmaturia. X-ray examination revealed a recurrence again in the kidney operated upon last. Colon bacilli and cocci were present in the renal urine. We intend to remove the stone soon and to drain the kidney for some months.

Case 10. Aloisia H., female, aged 42 years, had had pains in both loins for the last 10 years. Of late she had lost considerable weight. There was a tumor on the right side of the abdomen, the urine was strongly purulent and there was scarcely any indigocarmine excretion from either side. A roentgenogram (Fig. 5) was taken. In December, 1926, nephrostomy was done on the right pyonephrotic kidney and the stone removed. Through an accident the kidney drain slipped out 8 days after operation and could not be reintroduced. A small fistula remained and the patient went home. She came back in August, 1927, with anuria and high fever; non-protein nitrogen 119 milligrams per cent and an emergency operation was done. An enormously dilated left kidney necessitated quick nephrostomy with removal of a very big stone. Other smaller stones lying in the calyces had to be left on account of the extremely bad condition of the patient. During the 4 days after operation 9300 cubic centimeters of urine were collected from the kidney drain; no urine from the bladder. Examination in June, 1928, revealed non-protein nitrogen content of the blood 32 milligrams per cent; indigocarmine appeared on the left side in 10 minutes; on the right side pure pus was excreted when the kidney was squeezed. Dilution and concentration test: specific gravity was 1004–1017. After patient's departure from the hospital no more news could be obtained from her. Notwithstanding the uræmic condition nephrostomy was effected with astonishingly good results and satisfactory recovery of the kidney function.

Case 11. Ludwig J., male, aged 50 years, had had purulent pleuritis 6 years before; several ribs had been resected and he had been kept immobile for 7 months. The examination of the urine was found to be purulent and contained colon bacilli. Indigocarmine failed to appear on the left side; on the right side it appeared in 5½ minutes (Fig. 6). A one stage operation was decided on to remove a concrement the size of a small cherry in the lowest calyx of the right kidney and on the other side the kidney itself as it was completely filled with an enormous coral shaped stone. It was found, however, during operation (October, 1927) that only nephrotomy on the right side could be performed on account of unforeseen difficulties, so nephrectomy had to be postponed until March, 1928. Pelvic lavage presented great difficulties. There was frequent expulsion of soft concrements and finally a ureteral stone the size of a nut formed in the lower part of the widely dilated right ureter. Ureterotomy was done in May, 1929. From that date on it was no longer possible to reach the pelvis with the ureteral catheter. More stones formed, and finally the patient suffered with anuria and chills. Twelve hours later through a nephrostomy one stone (June, 1929) was removed. After decapsulation it was found that the kidney surface was covered over with small abscesses. Notwithstanding these abscesses there was no fever after operation and 3000 cubic centimeters of urine was excreted within the first 24 hours. Actually patient enjoys good health, though having to wear a nephrostomy drain.

Case 12. Siegm. P., male, aged 50 years, had had pains for some time as well as fever and hæmaturia. The urine was very cloudy and contained leucocytes and cocci. No indigocarmine appeared on the right side after 10 minutes, on the left side it appeared in 3 minutes and was a dense blue. A roentgenogram showed a stone in the right upper ureter (size, 12 by 21 millimeters); on the left side a large stone filled the pelvis and reached into one calyx. As the man was very stout and the heart was not very good, the operation was not performed in one stage. In January, 1928, ureterotomy was done on the right side; in March, 1929, nephrotomy on the left side. Phosphatic stones were removed. Intensive postoperative treatment was given. In September of the same year the urine was quite free of pus cells and bacteria.

Case 13. Isabella P., female, aged 17 years, fell from the fourth floor of a house in July, 1928. She suffered fractures of the bony pelvis and calcaneus, injury of the spine (third and fourth lumbar vertebræ), with complete urinary retention, so that permanent catheter was necessary. In October 1928, for the first time small stones on the right side were expelled during colics. X-ray examination showed a conglomeration of small concrements in the right kidney region. Notwithstanding constant medication with urinary antiseptics, the urine remained very turbid, and stones were frequently expelled. Lavage of the kidney pelvis was done on both sides. In April, 1929, a roentgenogram showed the shadow of a stone the size of a bean on the right side and of another calculus the size of a pea on the left side. Though all fractures were healed, operation on the kidneys had to be postponed as the general condition of patient was so poor that she had to be sent away to convalesce.

In June, 1929, the stone on the right side became impacted in the outlet of the pelvis, and it was impossible to pass a catheter up into the pelvis. Patient had a high fever and it was necessary to do an emergency operation. The kidney presented several small and large abscesses, and during decapsulation because the parenchyma was badly damaged and pulp-soft it was slightly torn so that the stone was extracted through this opening. Nephrectomy, which seemed indicated, could not be performed because of the infection and lithiasis on the other side, so a nephrostomy was made. A month later the kidney drain was removed and the fistula closed quickly. At the end of September, 1929, recurrence of almost similar symptoms was noted on the left side. The operation revealed extensive perirenal adhesions, on account of which pyelotomy did not seem advisable. The parenchyma did not appear to be badly damaged. Nephrostomy with removal of the stone was carried out. The drain was taken out a week later. Postoperative lavage was carried out on both sides. In December, examination revealed completely clear urine without pathological elements, normal appearance

time of indigocarmine on both sides and negative roentgenograms.

CASE 14. Mendel T., male, aged 60 years, from 1922 until 1927 had undergone several operations for carcinoma of both mammæ and of the lymph glands; and had therefore gone through periods of prolonged rest in bed. In May, 1930, colics were noted first on the left side. In December, 1930, X-ray examination and intravenous urography revealed numerous small and large concrements in the right side, the largest of which was impacted in the upper ureter. The kidney was markedly hydronephrotic. In the left upper ureter was a stone the size of a hazelnut. Intravenous urography revealed after 3 minutes a slight filling of the left pelvis and slightly dilated calyces. Urine analysis revealed Staphylococcus albus and aureus. Indigocarmine appeared on the left side in 10 minutes and was faint blue; on the right side there was no excretion even after 15 minutes. Non-protein nitrogen content of the blood was 43 milligrams per cent.

In January, 1931, a ureterotomy was done on the left side and a soft phosphatic stone, tightly adherent to the mucosa, was removed. In February, the right kidney was removed. Patient went home (to Poland) in March, 1931, in good health but never answered any of our inquiries about his postoperative health.

CASE 15. Alex. Z., male, aged 47 years. In September, 1931, patient had attacks of colics. Roentgenograms showed stones on both sides. As stones were present in both kidneys, patient was dissuaded from operation at that time by his physician. In June, 1932, the indigocarmine excretion on the right side began after 3 minutes, on the left side no blue had appeared after 10 minutes. Staphylococci were found in urine from both pelves. Roentgenogram showed a stone the size of a small cherry in a calyx on the right side; on the left side a calculus blocked the upper ureter and there was present a hydronephrosis (revealed by intravenous urography).

A one stage operation seemed possible. The right side was done first. It was not possible to remove the solidly impacted stone by pyelotomy, so a small nephrotomy opening was made just above the stone which then was extracted with difficulty. As patient had suffered considerable loss of blood during nephrotomy and moreover as he suffered with asthma we did not think it advisable to prolong the operation to do a nephrectomy on the other side. That was carried out in July, 1932. Actually the urine is clear and contains no bacteria. This case is a good example of the necessity of operating upon patients with bilateral renal lithiasis as soon as possible, in order to stop the process of destruction.

These 15 reports include all personal cases of bilateral nephrolithiasis operated upon on both sides. In 9 of them a one stage operation had been planned (Cases 1 to 7, 11 and 15) and this decision was carried out in 7, but in 2 cases we met with such difficulties during the operation on the first side, that we did not think it advisable to prolong the operation by attempting to operate upon the other side.

In the 6 other cases the operation in one stage had not been planned; in 4 (Cases 8, 9, 10, 13) an emergency operation had to be performed on account of complete obstruction of one kidney together with high fever and palpable kidney swelling. As in these cases the general condition

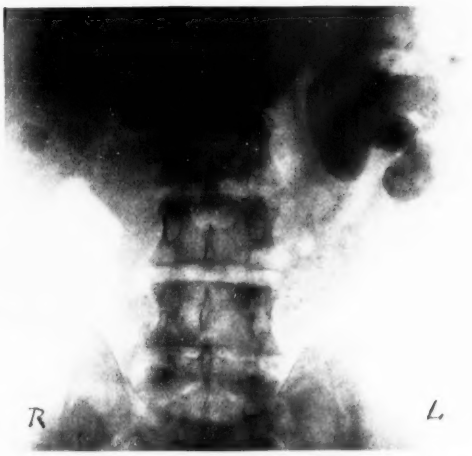

Fig. 6. Case 11. Nephrotomy on the right and nephrectomy on the left side in two stages.

of the patients was very bad, we had to work as quickly as possible; we could not even remove all of the stones and were compelled merely to institute a kidney fistula in order to relieve the kidney of the stagnating, infection laden urine. In 1 of the 2 remaining cases (Case 12) the condition of the patient, who was very corpulent and much weakened from long lasting fever, did not permit of a one stage operation; in the other (Case 14), as the function of the kidney to be operated upon first could not be depended on at the time and because of the age of the patient, we were reluctant to undertake a one stage operation.

The immediate results in these 15 operations were quite excellent; there were no postoperative deaths and no complications occurred at least within the uropoetic system. As to the more remote results, no recurrence of stones was seen except in Cases 5 and 11. In these cases it had not been possible to obtain complete sterility of the urine by the postoperative treatment. In Case 5 death followed bilateral parotitis after an operation to relieve a recurrence. In Case 11 patient is in excellent health although he has to put up with a permanent kidney fistula. In 6 cases (1, 2, 6, 12, 13, 15) we obtained complete sterility of the urine. Case 14 could not be followed further as patient went abroad and no news could be obtained.

In 3 patients (Cases 3, 4, 9) unfortunately small fragments of stones had been left behind. In 2 of these cases the fragments did not increase in size, the patients being still under observation. The kidney function is excellent, the urine is almost

clear; however a few bacteria are still present. Case 9, patient had to undergo another operation in order to get rid of the slowly growing stone. But there was another recurrence, perhaps due to in adequate postoperative treatment. Finally while in Cases 8 and 10 one could not expect to clear the urine of bacteria because of the greatly dilated condition of the renal cavities, operation nevertheless prolonged the patients' lives.

In 5 of the cases discussed, the etiology of the calculi formation was easily traceable: in Case 2 most probably as far as the stone on the left side was concerned a bone fracture produced by a shot; in Case 9 a long standing osteomyelitis during childhood; in Case 13 several bone fractures together with spinal injury; in Case 14 long standing disease necessitating immobility and causing infection. In Case 6, with the horseshoe kidney, the stagnation of urine in the pelves, which is peculiar to such cases, probably favored the implantation of a hæmatogenous cocci infection.

Another interesting finding is that in 13 of the 15 cases the calculi on both sides were composed of phosphates, one patient (Case 2) had urate stones on one side, and an oxalate stone on the other side. One patient (Case 7) had oxalates on both sides. Of the 13 cases with phosphate stones 8 had cocci in the urine (Cases 1, 3, 4, 5, 6, 12, 14, 15), 3 revealed cocci and colon bacilli (Cases 8, 9, 10), and in 2 cases colon bacilli solely were found in the microscopic specimen of the sediment (Cases 11, 13).

In 8 cases cultures of the urine were made (Cases 1, 3, 4, 5, 6, 12, 14, 15). They all revealed the Staphylococcus albus except Case 14, in which was also found the Staphylococcus aureus, which, when injected into a rabbit, displayed great virulence.

The microscopic examination of the stones dissolved in acids revealed in 9 cases (Cases 1, 3, 4, 5, 6, 9, 12, 14, 15) merely cocci and in 3 cases (Cases 10, 11, 13) cocci and Bacillus coli. This speaks strongly for the preponderant part which cocci infection plays in the etiology and development of secondary stones. (See my article in the *Klinische Wochenschrift.*)

The high percentage of phosphatic stones in our cases is noteworthy and it would be interesting to learn whether or not a similar percentage has also been noted by other surgeons who have treated bilateral renal lithiasis. Unfortunately, very little mention is made as to the chemical nature of the stones and the presence of bacteria in the urine. In the few publications which do report this, we have found the staphylococci stones mentioned frequently.

The practical deduction from these findings is that in the postoperative treatment we should direct our efforts essentially against the infection in order to free the urine of bacteria. This result can be obtained through medication or diet, but principally by means of lavage of the kidney pelvis. It is of course essential that a thorough examination and study of the case be made in order to search out and treat any possible seat of infection; for instance bad teeth, bad tonsils, disease of the adnexa, etc.

SUMMARY

Fifteen cases of bilateral nephrolithiasis are reported, 7 of which were operated upon on both sides in one stage; in the 8 other cases the calculi were removed in two stages. No postoperative deaths resulted. Operation on both sides at one sitting has great advantage over that in two sittings—a fact which should be more generally recognized. The indications for the surgical treatment of bilateral nephrolithiasis are discussed. The great influence that staphylococci infection has on the formation of secondary stones is demonstrated by clinical observation and by experimental research, and our knowledge in this particular is of great value in making our decisions as to the course of treatment to follow in cases with secondary stones.

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UTERINE CANCER

A Report Covering the Period June, 1927 to June, 1932[1]

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THIS report is purely a statistical one in which certain phases of diagnosis and treatment of uterine cancer are especially emphasized. No attempt has been made to include a follow-up of these cases. There were a total of 959 cases reviewed over this 5 year period. Of these, 926, or 96.6 per cent, were cervical, and 33, or 3.4 per cent, were fundal. These figures coincide closely with those reported from other clinics.

Of the 926 cervical cases, there were 407, or 44 per cent, in white women, and 519, or 56 per cent, in negroes. These figures differ somewhat from those of other clinics, but perhaps this may be explained by the fact that the negro admission at Charity Hospital is practically the same as the white, and also by the fact that the average southern negro woman is more likely to allow cervical lesions to remain untreated, even though they be causing symptoms that the average white woman would not endure. As a result, more prophylactic procedures are carried out on the white woman.

The average age in carcinoma of the cervix was 46, while in that of the fundus was 51 (Table I).

TABLE I.—AGE GROUPING

	CERVICAL		FUNDAL	
	Cases	Per Cent	Cases	Per cent
0–19 years	1	.091	0	
20–29 years	60	6.3	0	
30–39 years	196	21.1	4	12.1
40–49 years	323	35.4	12	36.4
50–59 years	234	25.11	6	18.1
60 over	112	12.0	11	33.4
Total	926		33	

The youngest patient in the cervical group was 15 years old; the oldest patient was 84.

Of the total number of 959 cases, 926, or 96.6 per cent, were multiparæ and 33, or 3.4 per cent, nulliparæ.

The number of cases in which a microscopic diagnosis of carcinoma was made was 268. This number is perhaps rather small, and the importance of a microscopic diagnosis in every case of carcinoma cannot be emphasized too strongly. Of these 268 cases, 93.5 per cent, were epidermoid in type, while 6.5 per cent were of the gland cell type. These figures also compare closely with those given by other clinics (Table II).

TABLE II.—MALIGNANCY CLINICALLY IN CERVICAL CASES

	Cases	Per cent
Early	104	11.5
Late	777	83.0
Untreatable	45	5.5

Clinically the cases were divided into 3 groups, early, late, and untreatable. By early were meant those cases in which the carcinomatous condition was limited to the cervix alone. There were 104, or 11 per cent, in this group. The late cases were those in which the carcinomatous condition had extended to the vaginal walls or to the parametrial tissue. There were 777, or 83.5 per cent, in this group. The untreatable cases were those in which metastasis throughout the pelvis was so extensive that treatment with radium or deep ray as a palliative procedure was not thought advisable. There was a total of 45, or 5.5 per cent, in this group (Table III).

TABLE III.—DURATION OF SYMPTOMS PRIOR TO RECOGNITION OF CARCINOMA

	Cases	Per cent
Under 3 months	260	34
3 to 6 months	220	29
6 months to 1 year	170	22
1 year and over	102	15

One of the main points that has been repeatedly emphasized as to early diagnosis of carcinoma is the duration of symptoms prior to the first visit of the patient to her physician. This is rightfully a most important point, and was carefully determined in our present series. As shown in Table III, of the 752 cases in which this point could be determined, the largest number of cases were found in the period under 3 months. There were 260, or 34 per cent, of the total that presented themselves for examination after having symptoms for 3 months or under. This is rather encouraging, as it shows that the laity are gradually learning that the time for examination is at the first suspicious sign of trouble. In the second group, that is from 3 to 6 months, there were 220 cases, or 29 per cent. In the third group, that is from 6 months to a year, there were 170 cases, or 22 per cent. In the fourth group, that is those over a year, there were 102, or 15 per cent. Newall in a report from

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Barnes Hospital in 1932, says that of the cases treated there during a 5 year period, the majority had waited for 6 months before applying for treatment (Table IV).

TABLE IV.—CASES TREATED BEFORE DEVELOPMENT OF CERVICAL CARCINOMA

Carcinoma following cauterization or some plastic operation on the cervix	10
Carcinoma following abdominal hysterectomies	21

Of equal importance in a statistical report as to the duration of symptoms prior to applying for treatment, is the number of cases that have been treated for cervical lesions prior to the development of a cancerous process. The treatment given is usually a cauterization or some type of plastic operation. Hunner subjected 2,895 patients with chronic cervicitis to either cauterization or amputation, and after 10 years not one had developed carcinoma. In our series of 926 cases, 10 patients had previously received some type of repair of the cervix, either cauterization or trachelorrhaphy or amputation. Of this group it is possible that a few had a carcinomatous condition present at the time of operation, as the interval from time of operation to recognition of the cancer varied from 3 months to 25 years. The majority, however, developed between 1 and 3 years, there being 4 cases under 1 year. In 21 cases the growths were found in the cervical stump following a supravaginal hysterectomy. The time interval of development of the carcinomatous condition varied from 2 months to 17 years. The majority, however, developed within 1 to 2 years. In George Gray Ward's report of 357 cases from the Woman's Hospital of New York City in 1933, there were 19 cases that followed a supravaginal hysterectomy, and in Smith's report of 550 cases in the Boston Free Hospital for Women there were 19 cases that followed supravaginal hysterectomy. Both of these reports showed a much higher percentage of patients in whom a cancerous condition developed than in our own series of 926 cases.

We now come to the most important phase of the cancer problem, that is treatment. In our series in 98.5 per cent of the cervical cases, the patients were treated with radium alone or combined with deep ray therapy; in 0.03 per cent patients were treated surgically. In the remaining cases any treatment even as a palliative procedure was impossible. In the fundal cases 70 per cent of the patients were treated surgically and 30 per cent with radium.

As to the amount of radium used in the cervical cases there is a great difference of opinion throughout the larger clinics and hospitals of the world. The dosages given in our present series vary greatly, due to the fact that there has been no standard adopted. On our service, however, we have now adopted the following plan: In the early cases the initial dose is a large one, namely 3,600 to 4,000 milligram hours, either at one stage or divided into two stages at an interval of 2 to 3 days. No subsequent irradiation is given for a period of at least 3 to 6 months. The amount at that time depends on the course of the disease. In the late cases we usually combine radium in doses of 3,600 to 4,000 milligram hours with the deep ray prior to, and following, the application of radium.

TABLE V.—DOSAGE OF RADIUM USED IN CERVICAL CASES

Cases	Per cent		Mgm. hrs. each
254	31.2	received a total of	1,200
259	31.8	received a total of	2,400
223	24.3	received a total of	3,600
76	9	received a total of	4,800
27	3.7	received a total of	6,000 (or over)

In Table V it is shown that of 839 cases in which the dosage was determined, 254 cases, or 31.2 per cent of the total, received only 1200 milligram hours each, this amount being quite inadequate. In 259 cases, or 31.8 per cent of the total, only 2,400 milligram hours was given to each. This, in our opinion, is the minimum dose that one could expect results from. Of the remaining cases, 223, or 24.3 per cent, were each given 3,600 milligram hours, 76, or 9 per cent, were each given 4,800 milligram hours, and 27, or 3.7 per cent, were each given 6,000 or more milligram hours.

TABLE VI.—NUMBER OF RADIUM APPLICATIONS

Cases	Per cent	Application
525	62	1
211	25	2
74	9	3
29	4	4 or more

As to the number of applications of radium used it is shown in Table VI that 525 cases, or 62 per cent of the total, received only 1 application, which in the majority of cases did not exceed 2,400 milligram hours; 211, or 25 per cent, received 2 applications; 74, or 9 per cent, received 3 applications; and 29, or 4 per cent, received 4 or more applications.

TABLE VII.—TREATMENT GIVEN ELSEWHERE

		Initial dose
G. G. Ward	Woman's Hospital, New York	3,600–4,200
F. C. Keene	Univ. Pennsylvania, Phila.	2,400
G. U. Newall	Barnes Hospital, St. Louis	2,000–5,000
G. S. Smith	Boston Free Hospital for Women	4,800–5,000
Arthur Curtis	Passavant Hospital, Chicago	3,000–4,000
	Bellevue Hospital, New York	7,500 plus deep ray

In Table VII the treatment with amount of radium used at many of the important cancer centers of this country is given. The standard adopted on our service here compares favorably with the majority of these.

SUMMARY

1. This report covers a review of 959 cases of uterine carcinoma—96.6 per cent cervical, 3.4 per cent fundal.

2. The cases were distributed 44 per cent in white women, 56 per cent in colored.

3. The average age of the women with cervical carcinoma was 46; fundal, 51.

4. In 83 per cent diagnosis was made clinically late on first application for treatment.

5. In the majority of the cases, symptoms had been present for 6 months or under before patients applied for treatment.

6. In 10 cases carcinoma followed either cauterization or some plastic operation on the cervix; in 21 cases the cancer followed supravaginal hysterectomy.

7. The standard treatment used on our service at Charity Hospital is described, and compared to that used elsewhere.

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EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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CONSERVATION OF THE CIRCULATION IN BONE AND JOINT SURGERY

THE circulation undoubtedly should be duly regarded in surgery of all tissues, but the soft tissues are more resourceful in the restoration of blood supply when rendered deficient by operative procedures, a pathological process, or trauma, than is bone and cartilage. Bone is by no means an inert tissue but has an abundant blood supply and one of its chief functions is the storage of calcium with a constant interchange with the blood stream to maintain the proper calcium phosphorus balance for every cell in the body. But the structure of bone is such as to retard revascularization. Hyaline cartilage, which forms the articular surface, has practically no blood vessels, consequently has very little restorative power *per se*. When the articular cartilage is injured or the source of nutrition, which is from the blood, is severed there is either degeneration with denudation or repair by invasion of blood vessels and the formation of fibrocartilage or fibrous tissue, thus permanently impairing the quality over the area involved.

The physiological repair of bone requires, in the adjacent soft structures from which the circulation is derived, an abundant blood supply, in consequence the old adage "keep close to the bone" in operative procedure for the purpose of avoiding large nerves and blood vessels, and to secure a better mechanical restoration, often defeats the object by destroying the means.

The blood supply to bone is derived from the nutrient artery and from the periosteum through the attachment of soft structures. The vessels from the periosteum are probably of more importance in the process of repair than the nutrient artery. When the blood supply to an area of bone becomes obliterated, either aseptic necrosis or sequestration occurs or there remains sufficient nutrition to keep the part alive but not to instigate the process of repair. In intracapsular fractures of the neck of the femur, the main supply is severed at the line of fracture, and the only source is derived from the small vessels in the ligament teres which may be sufficient to maintain a living head, but not to permit callus production, or there may not be sufficient supply from this source and the head may become an aseptic sequestrum. Repair then can occur only by invasion of the sequestrum by new bone.

The practical importance of this subject may also be illustrated in all phases of bone and joint surgery: in fractures, and whenever the bone is incised for any purpose, there must be an area of stasis between the fragments, surrounded by one of active circulation. If at

the time of trauma there is extensive crushing of the soft structures or if at operation there is extensive stripping of the periosteum and soft parts, healing will be impaired proportionately to the damage. In compound fractures the area of stasis or blood clot is extended and often there is also injury to the surrounding structures and repair is notably materially retarded.

In dislocations, the blood supply may be impaired with subsequent degeneration of the articular cartilage and sequestration of a large portion of the adjacent bone. This has frequently been observed in the hip joint, when the roentgenogram shows perfect reduction at the time of dislocation, but after months or years later gross irregularity by sequestration and disintegration. This was first brought to my observation many years ago in a healthy twelve year old boy with perineal dislocation of the hip. In unreduced dislocations of the shoulder and elbow after the elapse of a few weeks the cartilage at open operation shows evidence of fibrillation and degeneration which is often advanced to such a degree that restoration to normal may not occur even after reduction.

In extensive operations upon the knee joint, as in arthroplasty, a much better exposure can be secured by stripping of the periosteum for a considerable distance from the lower extremity of the femur. This undoubtedly facilitates mechanical reconstruction of all parts but later there may be sequestration on the articular surface of the femur and such gross irregularity that even though active motion is secured the purpose of the procedure is defeated. No defect in the articular surface of the tibia is ever noted, for the attachments of the soft structures are not disturbed.

In the hip joint the entire head and neck of the femur may disappear in the same manner when there is too extensive dissection of the soft structures. The acetabulum is rarely if ever affected as there is sufficient blood supply from the inner surface of the pelvis to maintain contour, therefore extensive denuding of the external surface of the ilium to secure exposure is permitted with impunity.

In osteochondritis dessicans of the knee in which an aseptic sequestrum is formed in the articular surface of the internal condyle of the femur and a loose body is extruded in the joint, a small artery, the arteria media, in the posterior crucial ligament is probably occluded thus obliterating circulation to this part. If, however, as occasionally occurs, this sequestrum through irritation becomes attached to the synovial membrane revascularization occurs and the sequestrum is transformed into active living bone: a beautiful natural illustration as to the behavior of free bone grafts. The same manifestations have been observed in the head of the astragalus, after fracture of the neck and after excision and replacement.

In all operative procedures upon bones and joints the incision and approach should be so devised that the circulation is impaired as little as possible. In the knee a sufficient exposure for all purposes may be secured by a linear incision parallel with the quadriceps tendon, patella, and patellar tendon, but, of course, a more tedious procedure is required to reach all recesses. U-transverse and other complicated incisions give a better exposure but necessitate severance of important structures. In operations upon fractures of the long bones it is much better to secure only a fifty per cent end-to-end engagement than to destroy the most potent means of repair, even though a perfect anatomical restoration may be secured.

There are other factors to be considered, as, the constitutional status of the patient, secretion of certain ductless glands as the para-

thyroid and calcium phosphorus balance, vitamins, and focal infections. However, from a practical point of view the problem has been found a local one in a very large percentage, which is chiefly controlled by the local blood supply and if impaired will either result in sequestration or a much retarded process of repair. WILLIS C. CAMPBELL.

RELIEF OF ACUTE ADHESIVE INTESTINAL OBSTRUCTION; BY SUCTION APPLIED TO INLYING DUODENAL TUBE

THE borders of medicine and surgery are not fixed but are constantly changing. We are continually striving to find means of treating surgically diseases which are refractory to medical management. At the same time an uninterrupted search is always in progress for conservative agents which may adequately replace satisfactory but more energetic operative intervention. These imaginative pursuits and dreams of medical men are often matters of stern reality to the patient afflicted with an internal disorder for which medicine can do nothing, as well as to the patient faced with the prospect of operation for the relief of his complaint. The one asks, "May not an operation help me?" the other, "Can not the same result be accomplished without operation?"

Since the advent of the era of surgery of the abdomen, operative treatment has had no rival in the management of acute intestinal obstruction, save for early cases of colonic intussusception which may occasionally be reduced by a barium enema. The employment of nasal catheter suction siphonage has demonstrated, however, that a large number of instances of simple acute intestinal obstruction of adhesive origin can be satisfactorily relieved by this means alone without operation. The rationale of its use rests upon this factor: Intestinal distention engendered by a block in the bowel is due essentially to failure of absorption of swallowed air and the digestive juices (bile, pancreatic juice, and hydrochloric acid) emptied in at the gateway of the intestinal canal. In the same manner that decompression by enterostomy of the gut obstructed by an adhesive band permits intestinal continuity to become automatically re-established, so similarly aspiration of the contents of the upper reaches of the distended intestinal tube together with removal of increments of swallowed air and digestive juices as they accumulate, often allows spontaneous restoration of the intestinal lumen. Enterostomy presents the following advantage over decompression by the duodenal tube: If following enterostomy, the gut continues obstructed, the intestinal tube above the site of drainage can be used as a nutritive tube while one waits to see if automatic release from obstructing mechanism will not occur.

Adhesive occlusions and the distention accompanying inhibitive (paralytic) and spastic types of ileus constitute the chief indications for the employment of suction in the treatment of acute bowel obstruction. In strangulation types of obstruction, whether due to hernia, volvulus, intussusception, or adhesive bands, operative interference is urgent. In the enormous distention of the colon, not infrequently observed in acute obstructions at the sigmoid flexure, the need for immediate decompression by operation of the ballooned gut is pressing. Correlation of physical findings with the roentgen film of the abdomen permits of surprising accuracy in the identification of the type of obstruction present. When, however, doubt remains concerning the nature of the obstructing mechanism, especially if uncertainty prevails as to whether a simple or strangulation obstruction be present, operation is in order.

In the treatment of mechanical obstructions by suction it is important to follow the decompression by X-ray films made at the bedside. Augmentation of the distention, no longer occurring because of the removal of swallowed air and fluid excreted into the stomach and duodenum, the intestinal colic usually stops soon after suction is commenced. The bowel having accommodated itself to a certain grade of distention, no pain will be appreciated if there be no increase in distention. Diminution in caliber of the distended intestinal coils rather than relief of pain herald a successful decompression. The appearance of gas in the colon in complete obstructions of the small intestine indicates that the continuity of the intestinal canal has been restored.

It may readily be shown in the intestine of the intact dog or in the human gut at necropsy that the exertion of suction at the duodenum is appreciated in the same degree at the terminal end of the small intestine in the presence of a pure gaseous or fluid distention of the gut. Such simple gaseous or fluid distentions may be completely decompressed almost at once. The usual clinical distention unfortunately is constituted by a mixture or alternate segments of gas and fluid in which decompression will be only gradually effected. Many factors affect this issue favorably, such as the elapse of time, with absorption of fluid from the gut resulting in confluence of gaseous increments which may then more readily be aspirated; the churning action of a turbulent gut and posturing of the patient to disarrange the existing collections of gas and fluid facilitating their removal by suction.

During the time when suction is in force, para-oral fluids (usually 5 per cent glucose in normal saline) are given in amounts adequate to insure a liberal daily urine output (700 to 1000 cubic centimeters)—a reliable mark of a positive fluid balance.

A large number of instances of acute adhesive obstruction, whether of remote or recent origin, will be spared the necessity of operation for its relief through the use of suction applied to an inlying duodenal tube.

OWEN H. WANGENSTEEN.

EARLY AMERICAN MEDICAL SCHOOLS

THE MEDICAL DEPARTMENT OF THE UNIVERSITY OF BUFFALO

JOHN L. ECKEL, M.D., BUFFALO, NEW YORK

THE Medical Department of the University of Buffalo was organized by an Act of Incorporation by the New York State Legislature on May 11, 1846. This was the culmination of many meetings and much discussion among the leading physicians and prominent citizens of Buffalo, which had extended over a period of many years.

During the boom period of the early thirties, a definite move was made to start a university with several departments, but the financial crash of 1836 blasted for a time the laudable plans of its promoters. Buffalo was already a city of some thirty thousand and the need for medical men was felt, hence the final determination of our citizens to compromise on the professional school first, with the hope of developing into a full university later. The fact that the Articles of Incorporation called for a university instead of just a medical school, showed the wisdom and breadth of mind of those early pioneers. However, while the charter granted was for a university, still the medical school was the only department for 40 years, when the pharmacy department came into existence in 1886. The law department followed in 1891; the dental department in 1892, and the analytical chemistry department in 1896; the department of arts and sciences in 1913; the department of education in 1916. Thus from a modest beginning, 86 years ago, when the enrollment was less than 70 students during the first year, the total registration in all departments at the present writing is well over 4,200.

Like most institutions of its day, the university was first organized as a joint stock corporation and continued so for over 50 years. There is no record of any dividend ever having been declared, but, on the contrary, very often there was an assessment to make up deficits that had been made necessary as the result of continued expansion and new equipment, the cost of which exceeded the income from student fees. The loyalty and self-sacrifice of the medical faculty under such conditions has been an enviable tradition, explaining the continued high standing and success of the medical department. Under such conditions it might be thought that the desire for gain by the stockholders might let down the bars for entrance and scholarship, but on the contrary, because of the high type of the faculty such conditions were never permitted to occur.

The original council consisted of 16 members, all stockholders, elected by fellow shareholders; the faculty, consisting of 7 physicians; the chancellor; and the Mayor of the city, *ex officio*. As each department developed, a member from that department was appointed to the council. All appointments to the teaching staff were made by the council upon recommendation of the faculty. Millard Fillmore (Fig. 1) was the first chancellor and continued to act in that capacity for 28 consecutive years, even during his encumbency as president of the United States.

The first faculty consisted of James P. White, M.D., professor of obstetrics and diseases of women and children; George Hadley, M.D., professor of chemistry and pharmacy; Charles V. Coventry, M.D., professor of physiology and medical jurisprudence; Charles A. Lee, M.D., professor of materia medica and pathology; James Webster, M.D., professor of general and special anatomy; Frank H. Hamilton, M.D., professor of the principles and practice of surgery and clinical surgery; Austin Flint, M.D., professor of the principles and practice of medicine and clinical medicine. Doctors Coventry, Hadley, Webster, Lee, and Hamilton also held chairs in the Geneva (New York) Medical College, an institution which had an honorable career for a number of years; but on account of its location in a small town, in 1872 it became the medical department of Syracuse University. As these teachers gave the early fall and winter courses at Geneva, the regular lectures at Buffalo did not begin until February. The lectures were preceded by preliminary courses of from 4 to 8 weeks, given by instructors. The enrollment the first year was 66 students. The first commencement exercises were held June 16, 1847, at which time 17 degrees were con-

Fig. 1. Millard Fillmore.

ferred by Chancellor Fillmore. The second session was attended by over 90 students, of which 32 received a medical degree. The department grew in size and importance, and soon the necessity for an adequate building was felt. The first three sessions were held in the old First Baptist Church (Fig. 2), at the corner of Washington and Seneca streets. In 1849, at the corner of Main and Virginia streets, a fine structure (Fig. 3) of rather unique design was built of brown stone, which was regarded at the time as one of the best adapted buildings of its kind in the country. The cost of this building was contributed largely by the generous citizens of Buffalo. In it provisions were made for a dispensary. In 1849, the Hospital of the Sisters of Charity was organized, and its location, adjacent to the college grounds, added greatly to the facilities for medical teaching.

The original faculty all remained during the first 5 years, thus crystallizing the plans and policies, which have been so successful for 86 years. From the original faculty, several attained both national and international prominence because of the brilliancy of their work. James P. White, M.D., professor of obstetrics, was the inventor of the White forceps, and these are still being used in our day. In 1850 Dr. White introduced clinical midwifery in the college curriculum. While this method of teaching had previously been established in Europe, its introduction into America by Dr. White caused very severe criticism. The newspapers of Buffalo and vicinity attacked Dr. White so bitterly that a suit for libel followed, and while the defendant was

Fig. 2. First home of the medical college, 1846–1848.

acquitted, it served to vindicate Dr. White and his method of teaching. It was also Dr. White and his associate, Dr. George S. Burwell, who, acting upon the suggestions of Sir James Y. Simpson, of Edinburgh, demonstrated the practical employment of anæsthesia in the practice of obstetrics.

Dr. White was a very broad and active man, having many interests outside of his specialty in obstetrics. He helped materially in developing the Young Men's Christian Association; the Sisters' Hospital; the Providence Retreat, for the care of the insane; the Buffalo State Hospital, of which he was a member of the board of managers and later president of the board. His services continued with the medical school for 35 consecutive years.

The second internationally known man of that first faculty was Dr. Austin Flint (Fig. 4). In 1842 he was appointed health officer of Buffalo. In 1845 he established the *Buffalo Medical Journal*, and continued as its editor until 1853. In 1846 he was one of the founders of the medical school and continued as professor of medicine until 1859, when he went to New York as professor of medicine at Bellevue Medical College. It was in 1843 that Dr. Flint made his noted observations upon typhoid fever during an epidemic of that disease which occurred in North Boston, New

Fig. 3. Second home of the medical college, 1849–1893.

York. He contributed greatly toward the recognition, the source, and the means of conveyance of the infection in this dreaded condition. His work on diseases of the chest is a matter of history.

The third famous member of the original faculty was Dr. Frank Hastings Hamilton, who, for 15 years, was professor of surgery. He was a brilliant teacher and laid the foundation for perfected methods in the management of bone injuries and dislocations. His treatise, entitled *Fractures and Dislocations*, was translated into several languages. Dr. Hamilton made the first successful skin graft recorded in America, when he took skin from the leg of his patient and covered an ulcer of the opposite leg, 7 by 4 inches. This article was published in the *Buffalo Medical Journal* in December, 1854. Dr. Hamilton left Buffalo in 1860 to become professor of surgery in the Long Island Medical College.

Another notable man on the faculty in those early days was Dr. John C. Dalton, Jr., who became professor of physiology in 1851. He was the first in America to employ the method of experimentation on living animals in his teaching.

Dr. Julius M. Minor was another noted surgeon on the faculty in the earlier days, being professor of special surgery. In 1869, he advocated the enucleation of ovarian tumors, a method which has been universally adopted and used to this day.

After the first few sessions of the medical school the length of the course of instruction was extended to 2 years of 5 months each. After 1870 the course was extended to 3 years of 6 months each. With the birth and development of the science of bacteriology, the need was felt for more practical training in pathology and chemistry and a more accurate knowledge of anatomy and histology, all of which demanded increased laboratory facilities and more time. A new building was erected to meet this demand, through the generosity of the citizens of Buffalo, this being built in 1893 (Fig. 5). From 1884 to 1893, in addition to the regular course, supplementary and special instruction was given during the spring months. This was followed in 1893 by again lengthening the course to 7 months, and some years thereafter to 9 months for each of the four student years. In 1898 the amalgamation of the medical schools of Buffalo was accomplished, whereby the medical department of Niagara University was merged into that of the University of Buffalo. The former school had been doing excellent work for 15 years, having maintained a high standard throughout. The union was a decided advantage, as it served to place at the disposal of one school practically all the available clinical material of the city, which at that time numbered well over three hundred thousand people.

Following the Civil War, other men on the faculty became renowned. Chief among them was Dr. Roswell Park, who came from Chicago to Buffalo in 1883, as professor of surgery, which

chair he held for 31 years. He was a great influence, not only in the school and in the community, but throughout the United States and Europe. His textbook on *The Principles and Practice of Modern Surgery* in two volumes, published in 1907, was one of the best works on surgery ever written. It was he who observed the ever increasing number of cancer cases, and it was he who persuaded the New York State Legislature to found an institution for the study of malignant diseases. This demand was granted and the Institute for the Study of Malignant Diseases was established in Buffalo in 1898, Dr. Park being made its first director. During the first 3 years, research work under Dr. Park, assisted by Dr. Harvey Gaylord, was carried on in the University laboratories. In 1891, through the generosity of Mrs. W. H. Gratwick, of Buffalo, the present main building of the Institute was built, which since has grown into several buildings, and thus Buffalo boasts of the first institution in the world devoted entirely to the study of malignant diseases.

Dr. Thomas Rochester succeeded Dr. Flint as professor of medicine and continued the high standards created by his predecessor until 1887, when after his death he was succeeded, in turn, by Dr. Charles G. Stockton, which position Dr. Stockton held with honor until 1919. He was one of the outstanding internists of his day and did monumental work in maintaining the high standard of the medical school.

The Medical Department of the University of Buffalo has from the start been co-educational, but it was not until 1876 that a woman received a degree. Since then nearly every class has contained several women. The medical school has ever maintained a high standard, ranking favorably with the largest institutions in the country. In the matter of improving medical education it has been in the front rank in enlarging its curriculum and enlarging the corps of its teachers. The school is proud to claim among its teachers, not only the men already mentioned, but such other noted teachers and clinicians as Dr. Mathew D. Mann, Dr. Charles Cary, Dr. Grover W. Wende, Dr. James Gibson, and many others.

The building of 1893, with a number of additions, continues to serve the medical department. In 1913, the department of arts and sciences was established. Two years later premedical requirements in the State of New York rose to 2 years' college work. The medical school met this requirement through its department of arts and sciences. In line with the general trend of medical education, the Buffalo school has limited its freshman class to 77 members. The average number graduated is approximately 60 in each class.

Fig. 4. Austin Flint, 1812–1886.

From the very modest beginning 86 years ago, with a faculty of 7 physicians and 66 students, there are today in the department approximately 250 students, with a faculty consisting of 23 professors and nearly 200 associate professors, assistants, and instructors.

While for many years the school was on a stockholders basis, that condition passed many years ago. The opening of the arts department in 1913 was almost wholly brought about through long planning by the faculty of the medical department, especially Dr. H. U. Williams, who foresaw that increased requirements for entrance to the medical department were necessary. The result has been a closer union with the other departments of the university and from this a different method of government and support necessarily followed. In 1915 changes were made, transferring the governing power to an administration board of 10 members, nominated by the general faculty and appointed by the council and a board of instruction of 12 members, consisting of the heads of the teaching departments, or those designated by them, and a number of standing committees. Some modification has since been made, and at the present time admin-

Fig. 5. Part of present building of the medical department, built in 1893.

istration of the school of medicine is vested in the university council, the Chancellor, the Dean, the faculty, and two boards—the executive committee and the board of instruction. The executive committee has nominating power of physicians to the faculty, while the Chancellor and council must give approval.

The means of support are through fees from students and donations. Since 1921 two huge campaigns, appealing to the citizens of Buffalo, have been made, each led by the late Walter P. Cooke, each for five million dollars, and each has gone over the top, showing the continued interest and generosity of the citizens of Buffalo in this great educational institution. The university has never depended on any one great benefactor, but more on modest donations from a great number of its loyal friends. As a result, Buffalonians look upon the institution as belonging to them. It receives no support whatever from the City of Buffalo. All this demonstrates what unanimity of purpose, effort, and loyalty can do to put forward and perfect an institution.

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THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THERE has been no work in English even attempting to cover the subject of the clinical physiology of the eye—a subject in which more advances have been made in recent years than in any other department of ophthalmology. Very little consideration is given to the question in the textbooks, the only exception being the recent large work of Duke-Elder. In the foreign literature the matter is treated in monographs covering particular subjects, or in various parts of large handbooks. Thus the appearance of a single volume covering this subject is a boon to ophthalmologists everywhere and to many physiologists, bio-chemists, and psychologists who are interested in the subject.[1]

The author has renounced an attempt to prepare a complete reference book but has chosen what he considers the most important of these works for a discussion simple enough to be read with pleasure by the average clinician who possesses an interest, but no technical training, in the more scientific aspects of his subject. The bibliography covering several thousand titles will save much time to workers wishing to go more completely into any special phase.

The author, a clinical ophthalmologist who has done important work in physiology of the eye at the University of Pennsylvania, was well fitted to perform his task. If there is any criticism of his general method, it would be of his reticence in passing personal judgment on many of the subjects discussed in properly emphasizing work of varying importance. Thus Fischer's work on the permeability of the cornea, which rests on exceedingly complicated procedures and has never been confirmed, might be taken as proved from the author's statements and one wonders just how Tagawa was able to prove the existence of trophic nerve fibers by photographing the cornea. This criticism applies especially to some statements in the first chapter, on the Protective Mechanism of the Eye, including the functions of the lids, lacrymal apparatus, cornea, and conjunctiva.

The second chapter deals with the iris and pupil. Again one might gain the impression that the origin of heterochromia iridis from a lesion of the cervical sympathetic was to be definitely accepted, but the discussion of the pupillary pathways and their clinical examination by newer instruments is excellent. It is a subject on which the author has made original contributions. It may be recalled that no satisfactory explanation of the miosis which is associated with the Argyll Robertson pupil has ever been made. The author quotes some evidence that it is due to cord changes which remove the sympathetic inhibitory fibers to the sphincter. These are known to exist as part of the system of reciprocal innervation existing in the iris, as in other muscles. A relative miosis occasionally seen after mastoid operations apparently results from damage to sympathetic fibers which pass through the middle ear.

The mechanism of accommodation, which is next considered, is still unsettled. The author summarizes evidence for both the Helmholtz and Tscherning theories. He apparently favors the former, as modified by Henderson. The chapter on the lens and vitreous is perhaps necessarily too short to include a great deal of important material, and one misses a discussion of Baurmann's work.

Visual acuity is discussed in its physiological aspects and the visual pathways are described, including a discussion of recent work on the projection of retinal elements in the occipital cortex. Of great interest is the discussion of objective changes in the retina during exposure to light. The electrical reactions, too complex for discussion in a review show striking similarity to the phenomena of vision.

In a chapter on the subjective characteristics of vision the phenomena of dark adaptation and other phenomena are well discussed. The discussion of entoptic phenomena will be welcome to the clinician who is often asked their meaning by patients.

A discussion of the ocular movements stresses especially reciprocal innervation which the author has aided in proving for the extra-ocular muscles. The anatomic basis of nystagmus is also presented clearly.

Chapters dealing with the aqueous humor and the intra-ocular pressure take up the vexed question of the genesis and circulation of the aqueous. The author, whose work has helped to disprove the secretion theory, believes the aqueous to be a dialysate of the blood, but thinks some circulation out of the eye through the canal of Schlemm must be considered probable.

The typography of the book, except for a number of misprints, is good, and the illustrations, chiefly diagrams and records of experiments, are satisfactory.

SANFORD R. GIFFORD.

THE Jaschke-Pankow textbook of gynecology has been one of the standard German works for many years. The fourth edition was published eight years ago, and the present fifth edition[2] attempts to bring

[1] CLINICAL PHYSIOLOGY OF THE EYE. By Francis Heed Adler, M.A., M.D., F.A.C.S. New York: The Macmillan Company, 1933.

[2] LEHRBUCH DER GYNÄKOLOGIE. By Dr. Tud v. Jaschke and Dr. O. Pankow. 5th ed., Berlin: Julius Springer, 1933.

the subject matter up to date. This comparatively long gap has necessitated many revisions, some of the chapters being completely rewritten. Many of the illustrations have been replaced by new ones, more have been added, and the large number of drawings in color add to the value of the book as a text.

The section on hormones and on hormone therapy has been completely revised. This subject is admirably handled, and includes all the recent work in this field. The chapter is especially well written in the simple and direct style for which these authors are known.

Pankow is still of the opinion that surgery offers results at least equal to those of radiation in the earlier stages of carcinoma of the cervix. In the section on radiation therapy the author states that 6000 milligram hours is the upper limit of radiation. This is surprising in view of the present day tendency to use larger and ever increasing dosages.

The reader looks in vain for an adequate description of cervical cauterization, for pneumoperitoneum, either transabdominal or transuterine, sedimentation tests, and some of the other newer procedures which are in use at the present time, especially in this country.

The sections on the surgery of the various gynecological conditions are also well written. Emphasis is laid on surgical principles rather than on details of surgical technique. For these latter the reader is referred to larger works on surgery. The text has therefore been kept a most readable and useful reference for students and practitioners. It should be read as it is an excellent cross section of present day gynecology as practiced in Germany. Its style and illustrations make it enjoyable as well as profitable. For the *Frauenarzt* it is an excellent companion volume to the *Lehrbuch der Geburtshilfe* by the same authors. RALPH A. REIS.

KELLOGG has presented us with a most valuable monograph indeed.[1] The duodenum is exhaustively considered from the standpoint of its structure and function, its diseases, and their medical and surgical treatment. As Doctor Stewart aptly says in the foreword, "here is gathered all that is definitely known and here is judicially considered all questions that are still moot. . . . the older surgeons will find it stimulating and practical, the younger will find that, and further, that it is time-saving." The subject matter is presented in twenty-six chapters which cover the anatomy, physiology of the duodenum and all of its diseases and their treatment. The extensive literature has been thoroughly studied and made readily available. The numerous illustrations which are well selected and instructive include a number of splendid specimens from the museums of the Royal College of Surgeons in Edinburg and London, Guy's and Saint Bartholomew's Hospitals which the author personally studied. The reviewer finds no difficulty in according highest praise to Doctor Kellogg for this volume. FREDERICK CHRISTOPHER.

THE fourth edition of the treatise on the *Science and Practice of Surgery*[2] is dedicated by the authors to their friend and teacher, Sir George Makins.

The first volume is devoted to general surgery and covers in a brief way the usual elementary subjects: Antiseptics; sterilization; pre and postoperative care of patients; inflammation; infections; hæmorrhage and anæsthesia. The chapters on surgery of blood vessels and nerves are concisely written and there are occasional references to historical operations which have served as the ground work for our present day methods. Chapters 14 to 17 inclusive were written in collaboration with R. H. O. B. Robinson and are devoted to fractures and dislocations. These chapters have been thoughtfully written and display a nice choice of detail in the treatment of the more common fractures and their complications.

Volume ii is devoted to regional surgery and the authors have prefaced many chapters with short accounts of applied surgical anatomy and physiology of the region or organ discussed. This feature, the reviewer feels, is an excellent one and will probably find its way into many future publications.

In the preface to the first volume, the authors have stated that they had two main objects in view in presenting this two volume work: the first being to place before the student a book which is sufficiently comprehensive to provide him with all that he will require in passing both his ordinary surgical examinations and any higher examinations to which he may aspire, and the second, to present a book which may be of value as a work of reference to the medical practitioner. One is inclined to agree readily that they have attained their goal. The work shows the result of adequate condensation, while its comprehensiveness is quite astonishing.

The illustrations are liberal in number and well chosen. The reviewer, however, feels that the value of the volume might be enhanced somewhat by a more liberal interspersing of the illustrations with diagrammatic line drawings, which, in some of the recent monographs on surgery, have been so instructive.

The reviewer was probably unduly disappointed over the misspelling of the names of his urban colleagues, Frederic Besley and E. Wyllys Andrews. The incorrect description of the gastrostomy operation devised by Emanuel Senn of Chicago stuck out like a sore thumb.

The reviewer feels that this two-volume edition should be a valuable addition to anyone's library; it, however, will be especially useful to medical students and general practitioners. R. W. MCNEALY.

[1] HOEBER'S SURGICAL MONOGRAPHS. THE DUODENUM; ITS STRUCTURE AND FUNCTION, ITS DISEASES AND THEIR MEDICAL AND SURGICAL TREATMENT. By Edward L. Kellogg, M.D., F.A.C.S. With a Foreword by George David Stewart, M.D., F.A.C.S. New York: Paul B. Hoeber, Inc., 1933.

[2] THE SCIENCE AND PRACTICE OF SURGERY. By W. H. C. Romanis, M.A., M.B., M.Ch. (Cantab.), F.R.C.S. (Eng.), F.R.S. (Edin.), and Philip H. Mitchiner, M.D., M.S. (Lond.), F.R.C.S. (Eng.). 4th ed., vol. i, GENERAL SURGERY; vol. ii, REGIONAL SURGERY. Philadelphia: Lea & Febiger, 1933.

THE contributors to the first edition of Morris' *Human Anatomy*[1] were ten Englishmen, all of whom were associated with hospitals in or near London; the work itself was designed for the use of students "preparing for the Conjoint Board of the Royal Colleges of Physicians and Surgeons, for the Fellowship of the Royal College of Surgeons," etc. The contributors to the current ninth edition are twelve Americans, who hold, or have held, the appointment of professor of anatomy, in medical schools in the United States; no one of the original writers of the work, first published forty years ago, is on the present list. This change from British to American authorship was well under way with the appearance of the fifth edition—the first under Dr. C. M. Jackson's editorship—when eight of the twelve were Americans.

For this thoroughly revised edition, "Some parts have been almost entirely rewritten, this applying to the following sections: Special Sense Organs, Urogenital System, Glands of Internal Secretion, Osteology and Articulations"; furthermore the "illustrations have received special attention—a considable number of those used in the previous edition have been improved, and 253 new pictures, of which 92 are in color have been included to take the place of those deleted"; this now brings the total to eleven hundred sixty six, an increase by one half again the initial number.

The new edition of the textbook possesses certain general and very valuable features, some of which are recent improvements: it contains an entire chapter devoted to the skin as an organ; the material upon clinical and topographical anatomy is now logically distributed among the several chapters, according to the particular organ system affected; the new knowledge of the growth of human body and its parts is made available to the student; serviceable tabulations of muscles by functional groups and by segmental nerve supply are added. Typographically, the discriminative plan is retained whereby the student is led first to seek the fundamental facts printed in large type, and later, for careful reference, the details printed in small type.

The superb text descriptions which characterize the volume are frequently handicapped by unfortunately inadequate illustrations, many of which have remained unimproved through four decades. This is a curious shortcoming in a text which represents a mature science long since replete with surpassingly excellent pictures, and in an age when fine engraving and color reproduction are commonplace in nonscientific books. The old retained figures seem especially inadequate in the section on musculature, wherein the painstaking accounts of muscular and fascial attachments and relations are not revealed in the illustrations—the latter being serviceable only to verify the cruder features and not as reminders of careful laboratory experience; but it can be said that these myological figures, originally untinted, are now less garishly scarlet and therefore more natural, than they were, say, in the sixth edition. In the first editions, the arteries were dully, the veins too deeply colored; in the sixth edition, they were deeply colored but diagrammatically clear; now in the general process of toning down pigment, they are not sufficiently clear wherever the background contains a complexity of other structures. In addition, certain of the borrowed figures have been villainously treated both as to reproduction and coloring; elsewhere, obscure specimens of dissections are retained —not old enough to be of historic interest, and too rough to deserve inclusion in a newly revised text; some larger dissections require study before even the experienced can understand them. On the other hand, some new figures added from the authors' dissections, models, or diagrams are forcefully clear (and often unique, as one may find, for example, in the sections upon the organs of special sense and upon the urogenital system.)

An early edition contained the statement that "one criticism upon most of the current textbooks of human anatomy, is that they are too extensive for the beginner"—a criticism, that is even more applicable now than then, since the curricular time allotted to gross anatomy has been through the years greatly reduced; and yet this work continues, in the traditional manner, to be encyclopedic, containing to about one-sixth of its bulk material that is nowadays handled admirably by the separate textbooks of embryology, neurology, and histology.

B. J. ANSON.

[1] MORRIS' HUMAN ANATOMY; A COMPLETE SYSTEMATIC TREATISE. Edited by C. M. Jackson, M.S., M.D., LL.D., 9th ed. Philadelphia: P. Blakiston's Son & Co., 1933.

THE authors divide salivary gland tumors into three categories: (a) epitheliomata (b) mixed tumors, and (c) sarcomata.[2] In their opinion many lesions which in the literature are recorded as sarcomata are actually carcinomata. Most observers will agree with the statement of the authors that it is impossible to predict or detect the point of departure at which a carcinomatous transformation occurs in the epithelium of a mixed tumor of the parotid. The monograph is introduced by an interesting and complete historical review of the subject.

The anatomical pathological discussion concludes with the belief that by far the majority of malignant tumors of the salivary glands are epithelial, the polymorphism of the connective tissue stroma is more apparent than real. There follows an excellent description of the symptoms, signs, clinical course, extension, recurrence, metastases and terminal stages of tumors of the parotid, submaxillary gland and accessory salivary glands.

After an elaborate review of the various methods of treatment pursued by different surgeons and radiotherapists the authors advise extensive radical resection of the primary lesion followed by radical surgical removal of the regional lymphatic glands

[2] BIBLIOTHÈQUE DU CANCER. Directeurs: Professeurs H. Hartmann and L. Bérard. Secrétaire: A. Chalier. CANCER DES GLANDES SALIVAIRES. By Charles Dunet and Jean Creyssel. Paris: G. Doin & Cie, 1933.

followed by postoperative radiation with X-rays or radium. Radium application after operation by means of molds at 7 centimeter distance is preferred by the authors to X-ray therapy. In the treatment of carcinoma of the submaxillary glands and mixed salivary gland tumors, wide surgical removal followed by postoperative radiation are also recommended.

The authors conclude that modern radium therapy can succeed in eradicating parotid tumors but the percentage of cures reported is low, whereas wide surgical removal followed by radiation yields 40 per cent three year cures.

This monograph constitutes a thorough, comprehensive, and authoritative review of the subject and takes its place among the best monographs upon tumors. An extensive bibliography is appended which should prove most useful to anyone specially interested in this field of tumor pathology diagnosis and treatment. MAX CUTLER.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

METASTASEN UND REZIDIVE IM KNOCHEN BEIM GENITALCARCINOM DER FRAU; UND IHRE DARSTELLUNG IM ROENTGENBILD. By Dr. E. Philipp and Dr. G. Schaefer. Berlin: Julius Springer, 1933.

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BENTLEY AND DRIVER'S TEXT-BOOK OF PHARMACEUTICAL CHEMISTRY. Revised by John Edmund Driver, Ph.D., M.Sc., A.I.C. 2d. ed. London: Oxford University Press, 1933.

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MATERNAL MORTALITY IN NEW YORK CITY; A STUDY OF ALL PUERPERAL DEATHS DURING 1930–1932. By the New York Academy of Medicine Committee on Public Health Relations. Ransom S. Hooker, M.D., F.A.C.S., Director of Study. New York: The Commonwealth Fund, 1933.

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GUIA PRATICO DE ANALGESIA TERRITORIAL. By Josè de Mendonça.

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BACTERIOLOGY; FOR MEDICAL STUDENTS AND PRACTITIONERS. By A. D. Gardner, D.M., F.R.C.S. London: Oxford University Press, 1933.

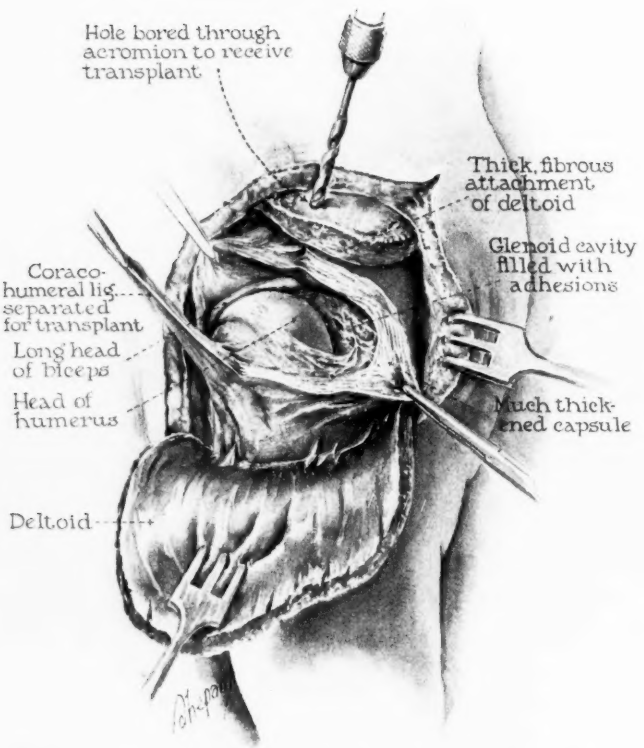
Hole bored through acromion to receive transplant
Thick, fibrous attachment of deltoid
Glenoid cavity filled with adhesions
Coraco-humeral lig. separated for transplant
Long head of biceps
Head of humerus
Much thickened capsule
Deltoid

Fig. 4. Capsule incised. Note thickness of capsule and fibrous tissue that obliterates the glenoid cavity—with biceps tendon in anterior portion. Coracohumeral ligament dissected free.

The Reduction of Old or Irreducible Dislocations of the Shoulder Joint.—William R. Cubbins, James J. Callahan, and Carlo S. Scuderi.